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Agricultural Experiment
Station
ORONO

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Summary Report of Progress, 1933



HIGHMOOR FARM, MONMOUTH, MAINE

FINANCIAL STATEMENT
For the Fiscal Year Ending
June 30, 1933

UNIVERSITY OF MAINE
THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE

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BULLETIN 369

INTRODUCTION

There have been some efforts throughout the entire country to curtail agricultural research on the assumption that the results of such research were instrumental in bringing about increased production. Research has never been anything but beneficial to agriculture or any other industry or profession. The fault, if there is a fault, lies in the application of the results of research. Knowledge is one possession, and perhaps the only one, which cannot be taken from one. It is ridiculous to state or imply that farmers or any other class of people may be benefited by ignorance, and it is only by study and research that any body of knowledge is accumulated.

The research of the Maine Station has continued along much the same lines as in past years although greater emphasis is being placed on the economy of production. Information which enables the farmer to produce his crop at a lower cost per unit of product is of especial value when the prices of farm goods are so out of line with the prices of other commodities. The progress of the year is given by each Department of the Station in the following pages.

AGRICULTURAL ECONOMICS

AN ECONOMIC STUDY OF THE COST OF COLLECTING MILK AND CREAM IN MAINE. George F. Dow. The analysis of the results of this study to date shows that many factors affect the cost of collection. Important among these factors are the method of collection, such as hauling by individual dairymen, by dairymen exchanging turns, or by hired collectors; distance from farms to receiving plants; volume of milk or cream hauled per trip; condition of roads; and extent of duplication of routes by several hired collectors.

The purpose of this study is not only to determine how milk and cream may be collected more economically but also to present economic information on present conditions and trends in collecting milk and cream. Since 1928, rapid changes have occurred in the frequency of delivery, in the method of collection, and in the

distance which milk and cream are hauled. In 1928, milk was delivered by Maine dairymen an average of only 4.1 times per week, and cream was delivered an average of 2.6 times per week. Since then, the dairy industry in the State has gone to considerable expense to improve further the quality of milk and cream. One of the most important steps taken in this quality improvement program has been to increase the frequency of delivery so that in 1931 milk was delivered an average of 6.5 times per week and cream an average of 3.0 times weekly.

Quality has also been improved by farmers and hired collectors by protecting milk and cream from excessively hot and cold temperatures during hauling, through the use of canvas and blankets. More recently, insulated covered truck bodies, such as shown in Figure 141a, have been required for collecting milk at several plants in Maine that ship milk to the Boston market. One of these Boston dealers now has twenty-two collectors who are using insulated covered truck bodies in collecting Maine milk; and during 1934, all trucks of this dealer which collect milk in the State will probably have insulated covered bodies. Also, in 1933, one large receiving plant required all hired collectors to ice their



FIG. 141a. INSULATED COVERED TRUCK BODY USED ON A COLLECTION ROUTE IN HAULING MILK FROM THE FARM TO THE RECEIVING PLANT IN MAINE

The increased use of such equipment since 1931 has done much to improve the quality of milk and cream in the State.

milk en route if they arrived at the plant after 9:30 o'clock in the morning. During 1934, similar icing requirements are expected to be set up at other plants. These changes in the frequency of collection and in equipment used have done much to improve the quality of milk and cream in Maine.

Another important trend that has affected the collection of milk and cream in Maine has been the consolidation of receiving plants in the State and a consequent increase in the average hauling distance from farm to plant. From 1928 to 1933, the number of receiving plants of the larger dealers in Maine has been reduced from 92 to 63 plants, or a net decrease of nearly one-third of the total plants. For plants receiving milk to ship to out-of-State markets, the number has decreased from 23 to 8, or a 65 per cent decrease. For plants receiving cream to ship out of the State, the number of plants has been reduced nearly one-half. An example of the consolidation of dairy plants is the Whiting Milk Company's plant at Newport, which now receives milk not only from the relatively nearby milk producers, but from producers who formerly delivered to local plants at Carmel, Corinna, Dexter, Dover-Foxcroft, Etna, Hermon Pond, and Pittsfield. Another illustration is the Turner Centre System, which, since 1928, has closed its plants at West Benton, Winthrop, South Paris, and Richmond, and now has milk trucked directly to the central plant at Auburn.

The closing and consolidation of many receiving plants since 1928 has resulted in many economies, especially in the cost of handling milk at the plant; but the average hauling distance from farms to receiving plants has increased considerably. In 1928, the average hauling distance was 3.3 miles for milk and 5.2 miles for cream, as determined in a study of 178 dairy farms fairly representative of the State as a whole.¹ In 1931, the hauling distance had increased to 12.5 miles for milk and 14.3 miles for cream, the averages for 1,802 dairymen throughout the State.

The rather rapid increases in hauling distance due to the consolidation of plants also has had a tendency to increase hauling costs. Certain economies, however, have been effected that have prevented any material increase in cost. By closing certain plants,

¹ Dow, George F. *The Costs and Returns in Producing Milk, Raising Heifers, and Keeping Herd Bulls in Maine.* Maine Agr. Exp. Sta. Bul. 361, p. 74. 1932.

some collectors have been able to add new patrons and thus increase their volume per trip. This extra volume per route made it possible for some producers to get their milk or cream hauled longer distances with no material increase in the cost per hundred-weight for collection. In many cases, the problem of an increase in mileage has been met by a change in the method of delivering milk and cream. For example, it has often been possible on a collection route to haul long distances to a central plant as cheaply as a dairyman could haul his own milk and cream to a local plant—if a fair value were placed on the dairyman's own labor and use of equipment. As a result of recent increases in the hauling distances, there has been a decided change in the method of collection as is shown in Table 1. In 1928, 40.6 per cent of the milk of all producers selling to the larger dealers in Maine was delivered by dairymen directly to the plant, whereas in 1931, only 22.4 per cent of the milk was delivered by dairymen. The proportion of milk hauled by hired collectors increased from 35.5 per cent in 1928 to 76.2 per cent in 1931. The balance of milk was shipped by railroad. In a similar way, cream delivered by dairymen decreased from 33.6 to 20.4 per cent of the total cream; and that hauled on collection routes increased from 46.2 to 70.9 per cent of the total.

TABLE 1

Trend in the Method of Hauling Milk and Cream in Maine from 1928 to 1931

Method of hauling	Per cent of total milk		Per cent of total cream	
	1928	1931	1928	1931
Farmer delivered	40.6	22.4	33.6	20.4
Collection route	35.5	76.2	46.2	70.9
Railroad	23.9	1.4	20.2	8.7
Total	100.0	100.0	100.0	100.0

The increase in the amount of milk and cream hauled by hired collectors is due not only to less being delivered by farmers but also to less being shipped by railroad. In 1928, over one-fifth of all milk and cream was shipped by railroad whereas in 1931 only 1.4 per cent of the milk and 8.7 per cent of the cream was delivered by this method.

The rapid increase in the amount of milk and cream hauled on hired collection routes, as a result of plant consolidation, has been economically possible only through an improvement in the condition of roads and especially in the recent practice of snowplowing roads during the winter so that automobile trucks could be used throughout the year. In 1925, there was a total of only 3,287 miles of surfaced improved highway in the State. During the next eight years from 1925 to 1932 inclusive, the miles of improved roads increased to a total of 7,164 miles, or an increase more than equal the mileage built in all previous years.

The amount of roads snowplowed in winter has more than tripled from 1927-28 to 1931-32. In the winter of 1927-28, 3,075 miles of road were snowplowed in 217 towns, whereas in 1931-32, a total of 10,319 miles was snowplowed in 476 towns. At present, collection routes can operate automobile trucks throughout the winter over practically all the mileage of the important dairy sections of the State. In 1932, of 90 collectors interviewed throughout the State, a total of 77 had their routes snowplowed the entire length. On the other 13 routes, an average of about 70 per cent of the mileage was snowplowed. On only one short route was none of the road snowplowed.

These recent important changes in frequency of delivery, in the distance required to haul, and in the method of delivery make the results of this study of prime importance not only to show the trends in the collection of milk and cream but to determine how dairymen are reacting to the changes and how further economies may be accomplished.

ORGANIZATION AND MANAGEMENT OF MAINE DAIRY FARMS. George F. Dow. During the summer of 1933, a total of 290 dairy farm records was secured in the vicinities of Unity, Brooks, Belfast, and Union. These records were from adjoining areas of varying degrees of intensity of milk and cream production. The information includes detailed data concerning the organization and management of the farms and of the dairy herds in particular. The results of this study should show what types of farm organization paid best during the past year, and how farmers managed so as to cut costs and reduce losses to a minimum.

This study is important not only as a guide to farmers under present conditions but to show the trends in dairying that have

taken place since 1928 when a similar study was made of dairy farms for the State as a whole. Comparisons can thus be made between a year when farm returns were relatively high and a year during a major depression. From this comparison can be determined those principles of farm organization and management that pay best when returns are either high or low ; and also what changes should be made by dairymen to adapt their businesses to changes in the relative price level.

AN ECONOMIC STUDY OF THE POTATO INDUSTRY IN MAINE. William E. Schrupf and Charles H. Merchant. Information pertaining to the farm business and especially to the production of potatoes was obtained from operators of potato farms in Aroostook County and in central Maine. It was decided to use the information obtained in Aroostook County for the first part of the study, treating that obtained in central Maine separately. Farm business records were taken on 165 potato farms in Aroostook County for the three years ending March 31, 1929, 1930, and 1931. Subject-matter compiled includes farm capital, farm receipts, farm expenses, farm profits, farm acreages, crops, livestock, tractive power, and the relationships between labor income and size of business, production rates, use of capital, use of labor, and use of tractive power.

Farm Capital

The average capital of the 165 farms for the three years was \$28,815 per farm. The investment in real estate amounted to about 84 per cent of the total average capital, machinery nearly 8 per cent, and livestock, feeds and supplies the remaining 8 per cent. The investment in farm machinery increased about 10 per cent from 1928 to 1930, while investment in livestock decreased nearly 9 per cent.

Capital in real estate averaged \$24,168 per farm. About 40 per cent of this amount was in buildings and 60 per cent in land.

The amount invested in buildings was \$9,751 per farm, 43 per cent of which was in dwelling houses, 32 per cent in barns, 15 per cent in potato storage houses, and the remaining 10 per cent in tool sheds, garages, and other buildings.

The land was valued at \$14,417 per farm. About 84 per cent of this value was for crop land, 11 per cent for woodland, and 5 per cent for pasture land and land partly cleared for cultivation.



FIG. 142. AN AROOSTOOK COUNTY FARMSTEAD

Farm Receipts

Total farm receipts averaged \$9,720 per farm for the three years. About 90 per cent of these receipts were from crop sales. Receipts from sales of livestock and livestock products were 4 per cent of the total. Miscellaneous receipts and net increase in inventory were each about 3 per cent of total receipts. Farm receipts fluctuated considerably during the three years. For the year ending March 31, 1930, farm receipts were three and one-half times as large as in 1929. In 1931 farm receipts were nearly twice as large as in 1929. Total farm receipts per farm in 1929 were \$4,490, in 1930 they were \$15,912, and in 1931 they were \$8,757.

The average amount received from sales of crops was \$8,719 per farm. More than 98 per cent of total crop receipts came from sales of potatoes and less than two per cent from the sales of grain, hay, and other crops.

Farm Expenses

Total farm expenses averaged \$7,133 per farm for the three years. Farm expenses for the year ending March 31, 1930, were 9 per cent higher than in 1929. In 1931 farm expenses were about 23 per cent higher than in 1929. Cost of labor and fertilizer, together, accounted for more than half of the total farm expenses. Cost of labor was 28 per cent and cost of fertilizer was 23 per

cent of all expenses. Taxes, the third largest item of expense, accounted for 6 per cent of the total.

The average cost of labor (including board) was \$2,015 per farm. Expense for year labor was nearly 34 per cent of the total labor expense, contract labor 28 per cent, month labor 25 per cent, unpaid labor 8 per cent, and day labor 5 per cent.

Farm Profits

Average farm receipts for the three years exceeded average expenses by \$2,587. This amount represents farm income or the amount the operator received for his work and the use of the capital invested in the farm business.

Labor income was computed by subtracting 5 per cent interest on average farm capital from the farm income. The interest on average capital was \$1,441 per farm. The average labor income was \$1,146 per farm. For the year ending March 31, 1929, labor income was minus \$3,388 per farm, for 1930 plus \$7,440, and for 1931 minus \$614.

Subtracting the value of operator's time from farm income results in the return on capital. In 1929 the farms not only paid the operators nothing for their time and nothing for interest on average capital but lacked \$1,964 per farm of paying the year's expenses. In 1930 the farms returned \$7,473 per farm above the average estimate of the value of the operator's time. This was a 26 per cent return on average capital. In 1931 the farms failed by \$540 per farm of returning to the operators the value of their time as well as returning nothing on average capital. For the three-year average the farms returned \$1,186 more per farm than the value of the operator's time. This was 4 per cent return on capital.

Farm Acreage

The average size of farm was 170 acres, of which 60 per cent was in crop land, 22 per cent in woodland not pastured, 7 per cent in woodland pastured, 6 per cent open pasture, 4 per cent farmsteads, roads, etc., and 1 per cent land partly cleared.

Crop acreage for the three years averaged 102 acres per farm. About 40 per cent of the crop acreage was in potatoes, 33 per cent in hay, 23 per cent in grain (mostly oats), and about 4 per cent in green manure and other crops.

Crops

The average production for the three years of potatoes was 4,908 barrels per farm, of hay 39 tons, and of grain 983 bushels. About 84 per cent of the potatoes produced were sold, 10 per cent of the hay, and 13 per cent of the grain.

Of the three-year average of 4,111 barrels of potatoes sold per farm, 78 per cent were Green Mountain, 17 per cent Cobblers, and 5 per cent other varieties. The proportion of total barrels sold per farm that was Green Mountains increased from about 73 per cent in 1928-29 to more than 80 per cent in 1930-31. At the same time the proportion that was Cobblers decreased from more than 20 per cent to about 15 per cent, and other varieties decreased from 6 per cent to 4 per cent.

The average yield of potatoes in 1928 was 109 barrels per acre. In 1929 the yield was 136 barrels per acre and in 1930 it was 108 barrels per acre. The average yield per acre for grain in 1928 was 37 bushels. The yield was 47 bushels per acre in 1929, and 45 bushels per acre in 1930. Hay yield remained fairly constant during the three years at a little over one ton per acre.

The unweighted average farm price received for potatoes was \$1.99 per barrel (11 pecks) for the three years. The average price per bushel for oats was 76 cents. The average price of hay was \$10.05 per ton. The price of potatoes in 1929-30 was three times as large as that of 1928-29, and the 1930-31 price was twice as large. The price of oats declined 40 per cent from 1929 to 1931.

Available nitrogen content of commercial fertilizers used varied from 3.3 per cent to 10 per cent, available phosphoric acid from 6 per cent to 19 per cent, and water soluble potash from 7 per cent to 20 per cent.

The 4-8-7 formula was used more generally than any other. About 39 per cent of the average total cost of fertilizer was expended for this formula. During the three years the proportion of total fertilizer used having the 4-8-7 formula decreased 50 per cent and the proportion that was of higher analysis increased.

Lime was used on the land on 11 per cent of the farms in 1928, on 17 per cent in 1929, and on 12 per cent in 1930. The lime was all applied to the grain crop. Clover and grass were seeded with the grain. The average application of lime was about one-half ton per acre.

Manure was applied to nearly 14 per cent of the potato acreage. The average application of manure to potato land was 8.6 tons per acre.

Part of the crop acreage was in green-manure crops on about 9 per cent of the farms in 1928. In 1930 more than 27 per cent of the farms had part of the crop acreage in green-manure crops. The proportion of total crop acres that was green manure increased from 2 per cent in 1928 to nearly 4 per cent in 1930.

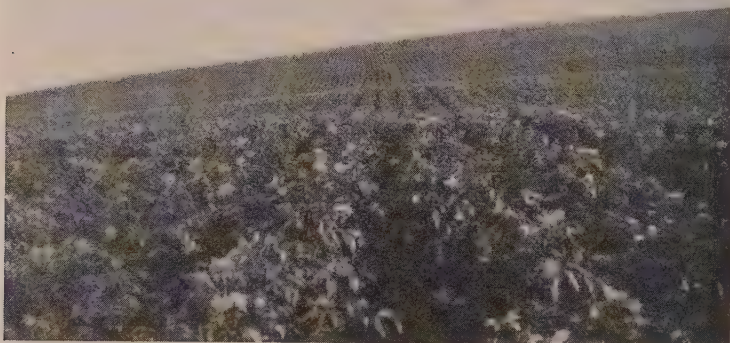


FIG. 143. A FIELD OF GREEN MOUNTAIN POTATOES

The yield on this field was 167 barrels per acre in 1929.

Livestock

Dairy animals, hogs, and hens were reported on practically all of the farms. On the other hand, beef animals and sheep were reported on relatively few of the farms. There were nearly three dairy cows per farm. There was about one heifer for each two cows and one bull for each 14 cows. The average flock of hens consisted of 29 birds. There was a small number of hives of bees. They averaged less than one hive per farm. Driving horses averaged less than one horse per farm.

Tractive Power

Work horses, tractors, and trucks were listed as tractive power. The number of horses decreased during the three years and the number of tractors and trucks increased.

On April 1, 1928, there were 672 work horses on the 165 farms. This number decreased to 667 on March 31, 1929, to 639 at the end of the second year, and to 602 at the end of the third year. This is a decrease of 10.4 per cent. During the three years 195 work horses were purchased, 168 horses were sold, and 97 horses died. The excess of the number sold and lost by death over the number purchased was 70 horses or 35.9 per cent.



FIG. 144. EXCELLENT HORSES ARE THE RULE IN AROOSTOOK COUNTY

There were no dual-purpose tractors reported at the beginning of the first year. During the year, six of these tractors were purchased. At the end of the second year there were 20 dual-purpose tractors, and at the end of the third year, there were 50 of these machines. The number of dual-purpose tractors increased 733 per cent from 1929 to 1931. In all, 51 of these tractors were purchased and one was sold.

At the beginning of the first year there were 90 tractors and at the end of the first year there were 94 tractors, other than dual-

purpose. The number decreased to 87 at the end of the second year and again to 77 at the end of the third year. The decrease from the high point at the end of the first year to the low point at the end of the third year amounted to about 18 per cent. During the three years, 22 of these machines were purchased, 29 were sold, and 6 were discarded.



FIG. 145. DUAL-PURPOSE TRACTOR WITH TWO-ROW POTATO DIGGING EQUIPMENT

Up to 1932 the number of tractors of this type had greatly increased while the number of tractors of other types and the number of horses had decreased.

There were 76 trucks at the beginning of the first year. At the end of the year there were 91 trucks. The number of trucks increased to 109 at the end of the second year and again to 134 at the end of the third year. In all, this is an increase of 76 per cent. During the three years, 97 trucks were purchased, 35 trucks were sold, and 5 trucks were discarded.

During the three years there was a net increase of 95 tractors and trucks (37 tractors and 58 trucks). During the same period there was a net decrease of 70 horses. The net increase in tractor and truck inventory was \$298 per farm while the net decrease for horses was \$167 per farm.

Labor Income in Relation to Various Factors

Some of the more important factors which influenced the three-year average labor incomes of the 165 farms were size of

business, production rates, use of capital, use of labor, and use of tractive power.

Size of business—The number of acres of potatoes per farm was the best measure of size of business for the farms considered. More than 90 per cent of cash receipts were from sales of potatoes. The three-year average labor incomes increased as the acres of potatoes per farm increased. The average labor income was \$581 on the farms having less than 25 acres of potatoes per farm. In contrast, on the farms having 53 acres of potatoes or more per farm, average labor income was \$1,988.

Production rates—The yield per acre of potatoes was one of the most important factors of production influencing labor incomes. As yield per acre of potatoes increased, labor income increased. The farms on which the yield of potatoes was less than 103 barrels per acre returned an average labor income of \$96 per farm. On the farms having a yield of more than 128 barrels of potatoes per acre the average labor income was \$2,310 per farm.

Use of capital—Value of crop land per acre is one measure of the use of capital. The value of farm land is, of course, influenced by the location of the farm in respect to shipping points and centers of population. In the main, however, the most productive land is the most valuable. Average labor income tended to increase as value of crop land increased. Farms having crop land valued at less than \$75 per acre returned a labor income averaging \$758 per farm. The farms on which the value of crop land was more than \$148 per acre returned \$1,540 in labor income per farm.

Value of potato machinery per acre of potatoes is another measure of the use of capital. As value of potato machinery per acre of potatoes increased the average labor income decreased, indicating that on many farms the investment in machinery was excessive for the number of acres of potatoes. Farms having less than \$22 per acre invested in potato machinery returned an average labor income for the three years of \$1,431 per farm. In contrast, on farms where the investment in potato machinery was \$38 or more, the average labor income was \$356 per farm.

Use of labor—Efficiency in the use of labor is measured by acres of potatoes per man. This measure is obtained by dividing the acres of potatoes by the number of twelve-month periods of man labor used on the farm during the year. The farms on which

labor was used most efficiently returned the largest labor incomes. On the farms having less than 11 acres of potatoes per man the average labor income was \$180 per farm. Farms on which there were 19 or more acres of potatoes per man returned an average labor income of \$2,415 per farm.

Use of tractive power—A measure of efficiency in the use of tractive power (horses, tractors, and trucks) is acres of potatoes per \$100 invested in tractive power. Efficient use of tractive power was an important factor in increasing labor income. Farms on which there were less than 2.2 acres of potatoes per \$100 of tractive power returned \$265 in labor income per farm. Farms having more than 3.9 acres of potatoes per \$100 of tractive power returned \$1,878 of labor income per farm.

LOCAL MARKET CONDITIONS AND REQUIREMENTS OF AGRICULTURAL PRODUCTS IN MAINE (EXCEPT AROOSTOOK COUNTY). Charles H. Merchant and Merton S. Parsons. This project is a study of local market conditions and requirements in an attempt to assist farmers in adjusting their agricultural production to more nearly meet these conditions and requirements where feasible. This study involves (1) securing information from stores, hotels, restaurants, and camps as to their purchases of agricultural products which are either now grown or can be profitably produced in the region and (2) securing information as to the practicability of farmers supplying local market requirements.

The first area selected for this study was York County. During the summers of 1932 and 1933, information was collected on (1) the purchases of agricultural products by stores, hotels, and restaurants in the larger towns and cities of the County, and (2) on farm businesses during the years ending April 1, 1932 and April 1, 1933. During the summer of 1932, information was obtained from 106 stores, hotels, and restaurants and from 206 farms. During the summer of 1933 similar data were obtained from 30 stores, hotels, and restaurants and from 206 farms.

The information thus obtained during the two years has been partly analyzed. In Table 2 is shown purchases of fowl and chickens from April, 1931, to June, 1932, by months. The information clearly shows the importance of the summer tourist trade as it affects the sale of dressed chickens during the months of July and August. Information on other farm products is being rapidly

assembled. The data obtained from farmers, in connection with this study, will assist in ascertaining the practicability of farmers supplying these local market requirements.

TABLE 2

Purchases of Dressed Fowl and Chickens by 106 Retail Establishments in York County from April, 1931, to June, 1932

Month	From farmers			From others than farmers		
	Pounds	Price	Cost	Pounds	Price	Cost
April, 1931	1,331	\$.277	\$ 369.06	1,165	\$.296	\$ 345.16
May	3,359	.270	907.62	2,019	.284	574.14
June	7,126	.285	2,030.68	5,463	.284	1,551.59
July	19,703	.276	5,434.86	31,360	.289	9,068.46
August	22,959	.272	6,236.37	41,701	.285	11,890.87
September	7,404	.316	2,338.90	8,046	.320	2,573.81
October	3,348	.277	928.58	1,362	.290	394.49
November	4,989	.262	1,305.74	2,183	.259	565.86
December	4,932	.249	1,226.08	3,102	.253	784.56
January, 1932	13	.257	3.34	686	.263	175.07
February	48	.244	11.70	817	.239	195.41
March	143	.254	36.30	1,108	.257	285.23
April	1,192	.250	297.49	1,101	.258	284.34
May	3,268	.277	906.74	1,574	.255	401.65
June	7,521	.264	1,989.33	5,196	.233	1,212.84
Total	87,336	\$.275	\$24,022.78	106,863	\$.284	\$30,303.53

PRICES OF FARM PRODUCTS AND PRICE TRENDS IN MAINE. Charles H. Merchant. The results of this study were published in March, 1933, as Experiment Station Bulletin 364.

THE EFFECT OF HANDLING METHODS ON QUALITY OF MAINE POTATOES. William E. Schrumpf. This study has been completed and the results were published in April, 1933, as Experiment Station Bulletin 365.

FARM TAXATION IN MAINE. Charles H. Merchant and Merton S. Parsons. This study has been completed and the results were published in June, 1933, as Experiment Station Bulletin 366.

THE PRODUCTION AND UTILIZATION OF MILK IN MAINE. George F. Dow. This phase of the dairy study has been completed and the results were published in July, 1933, as Experiment Station Bulletin 367.

ANIMAL BREEDING AND NUTRITION

MODE OF INHERITANCE OF MILK PRODUCTION AND ASSOCIATED CHARACTERS IN CATTLE. John W. Gowen. The cow's or sire's conformation has been the basis for breeding dairy cattle for many years. The thought underlying this practice was, that if the so-called "ideal" conformation were attained, the highest milk production would likewise be reached. The conformation of the cow or sire has been the basis for the sale of many cattle. The questions which remain to be answered are whether or not conformation is inherited and if so, whether or not conformation and milk production are correlated. If these characteristics are so inherited, the introduction of well-formed animals within a herd will tend to bring up the conformation of the future cows in the herd and their milk production, whereas, if not, the introduction of such animals is of but passing value. A group of 6,000 Jerseys were measured for eight body measurements, each measurement directly related to some element of conformation contributing to the ideal type. The study of these data shows that conformation is definitely inherited. The progeny show a marked tendency to repeat the good traits or the bad ones of their parents. Cows which are sisters are much more alike in size or other elements of conformation than are unrelated cows.

Inheritance seems to be the important factor in conformation. The form of the animal appears to be little influenced by such variations in feeding and care as exist in well-kept herds of Jersey cattle. The data show that the breeders of dairy cattle tend to mate animals which resemble each other. The items which are most subject to this selection are hip width, body length, and rump length. Unfortunately, as will be indicated later, these items do not have much importance to milk production.

The breeding of these Jersey cattle has followed definite family groups. The evidence shows that the Jersey breed has been split into non-interbreeding groups, each group characterized by a definite type. These types have been well standardized, the amount of variation found within the families being rather small. The inherited variation in conformation has thus been utilized practically to its full measure. Further selection within the herds must, in consequence, be devoted to the more refined points. If further

extensive changes in type are desired, resort must be made to crosses between families of the desired types.

The investigation on the relation of conformation to milk production which we have been making for a number of years has now been completed.

The results of this study warrant drawing general conclusions with respect to five or six questions. The age of the cow is always related to her milk production and to her conformation in such a manner that as age advances the milk production and the size increase up to mature form. In fact, the age of the cow is as fundamentally important to milk production as the total effect of the eight points which are here analyzed. This joint increase of milk yield and size with age creates a false correlation between milk yield and conformation. This false correlation may best be eliminated by judging only within age classes or if it is necessary to compare animals of different ages by correcting the measurements of both conformation and milk production to a standard age as was done for these studies. In the following discussion it is assumed that all records are age-corrected so that age no longer is a factor in the relation of type to production.

The weights of dairy cattle are related to their milk secretion in such a way that a relatively large weight means a relatively large milk flow. The food intake necessary to maintain this larger size, however, may partly or wholly overcome the advantage of weight. This seems to depend in part on the measure utilized in determining the economy of production. At the same time these cows should show relatively little fleshing at the withers, giving a wedge-shaped appearance when viewed from the front. These three facts find confirmatory evidence in a study of measurements of cows within the Holstein-Friesian breed, and of score-card records of Jersey Registry of Merit cows.

Besides the measurements taken for this study there are several others of importance. The first and foremost is the size and quality of the udder. The Jersey score-card data show that when measured by score, the size and quality of the udder are the leading qualifications of the heavy milking cow. The shape of the udder and the arrangement of the teats are of but minor significance as far as milk yield is concerned. This fact finds its strongest support in studies of actual udder weights related to the milk

yields of these udders. In these studies cows whose daily milk production and stage of lactation were known, were killed, the udders dissected off and weighed, and their composition determined. These results show that there is a close association between the udder tissue present and the amount of milk secreted, thus establishing the great importance of the size of the mammary gland to milk production.

The blood passing through the udder as it brings the basic materials from which milk is made is important to milk secretion. As an index of this blood supply it has been customary to use the appearance and size of the mammary veins, or milk veins. There is a relation between the size of these veins and the milk secreted by the udder sufficient to warrant their careful consideration in dairy cattle judging. The score-card data of the American Jersey Cattle Club support this view.

On the negative side it is shown that where the age, weight, and the wedge-shaped form are taken care of, the rest of the body measurements, such as height or depth at withers, paunch girth, width at hips, body length, or rump length, are of little importance. It is further clear that only one of the body wedges need be given consideration—that viewing the cow from the front, the side wedge and back wedge having little significance.

Before leaving a subject which has been given so much prominence in the writings on animal husbandry, it seems desirable to make a comparison between the different methods by which it is possible to estimate the probable future production of the cow. These methods are the cow's conformation for her age, a previous milk record of any length and her heredity for milk secretion (the record of production shown by her ancestors).

The comparison of these methods shows that a milk record either of a year's duration or of a week's length, or heredity as determined from the dam's and grand dam's, is much superior to conformation in indicating the productivity of the cow.

Conformation has another interest. It is asserted that the animal whose conformation is desirable will transmit high milk yield or butterfat percentage to its offspring. This belief is commonly maintained for the bulls, since it is argued that a bull of pleasing conformation, a winner in the show ring, is the bull to beget offspring which will be winners at the pail. These assertions

were more common 20 years ago, when dairymen did not bother to keep records, than they are today. However, they are common enough today to warrant investigation of the facts.

Study of the daughters of 208 measured Jersey sires and 122 daughters of measured dams shows that there is no relation of practical significance between the body type of the sire or dam and the productive capacity of the daughter in milk, butterfat, or butterfat percentage.

An extensive study of the effects of inheritance on the milk yields and butterfat percentages of Jersey cattle has been completed this year. The results show that inheritance accounts for about half the observed variation in milk yield and four-fifths of the observed variation in the butterfat percentage. The environmental variations which do exist in these Jersey records account for but little of the variation in the butterfat percentage and but 10 per cent of the variation in the milk yield. Dominance, assortive mating, and environmental variation, common only to the cow herself, account for the rest of the fluctuations in the yields and percentages of butterfat.

The sum total of the effects of inheritance on milk secretion may be seen in a typical pedigree of a high milk-producing cow as contrasted with one of low milk production. To make such pedigrees, we took all the Jersey cows whose mature form production was under 8,000 pounds as the low-producing group. There were 766 such cows in the 3,753 animals which came from tested dams. For the high-producing group we took all cows whose production was over 12,000 pounds. There were 738 such cows in the 3,753 animals which came from tested dams. The pedigrees of each cow were traced to the third generation. The average mature form production of the daughters of each animal in the pedigree was then determined, summed, and averaged. This average appears in the pedigrees presented below. Besides this average, the average productions of the dams, the paternal grand dams and maternal grand dams were found and that average also appears in the pedigree.

A glance at the pedigree of the average low-producing cow as contrasted with that of the average high milk-yielding cow shows that throughout, the production of milk by the ancestors of the high-producing animals is distinctly higher than that for the

LOW MILK YIELD

Daughters' milk yields under 8,000 pounds	SIRE	PATERNAL GRAND SIRE
		Daughters' average milk yield 9,844 pounds
	DAM	PATERNAL GRAND DAM
		Daughters' average milk yield 10,063 pounds
		Average Paternal Grand Dam's milk yield 10,327 pounds
		MATERNAL GRAND SIRE
		Daughters' average milk yield 9,401 pounds
		MATERNAL GRAND DAM
		Daughters' average milk yield 9,299 pounds
		Average Maternal Grand Dam's milk yield 9,129 pounds

HIGH MILK YIELD

Daughters' milk yields above 12,000 pounds	SIRE	PATERNAL GRAND SIRE
		Daughters' average milk yield 10,265 pounds
	DAM	PATERNAL GRAND DAM
		Daughters' average milk yield 11,183 pounds
		Average Paternal Grand Dam's milk yield 12,044 pounds
		MATERNAL GRAND SIRE
		Daughters' average milk yield 10,212 pounds
		MATERNAL GRAND DAM
		Daughters' average milk yield 10,710 pounds
		Average Maternal Grand Dam's milk yield 10,062 pounds

ancestors of the low animals. It will be further noticed that taking it as a whole the records of the parents are more nearly like those of their progeny than like those of the grandparents. There is, unfortunately, a selective factor which to some degree impairs this comparison. The cows which were selected for this cow group of necessity appear in the averages for the daughters of the sire or dam of that group. Similarly the high-producing cows appear in the averages as daughters of their parents. The effect on the average record of the sires' daughters is not pronounced since these selected cows occupy only one-fifth to one-seventh of the whole number of daughters. The effect on the average record for the dams' daughters is quite marked since these selected low or high daughters are a half of the whole number from which the average is obtained. There appears to be no really satisfactory way to overcome this difficulty. It does not affect the records of the grandparents or the average productions of the dams' own records. The difficulty does, however, vitiate any interpretation of the average records to show that the dam is more important than the sire in determining the record of the daughter. The marked selection of sires on the basis of the record of their dams is apparent in both pedigrees. The average productions of the daughters of all the grandparents are higher for the high group grand daughters than for the low group grand daughters. For each given group, the daughters of the paternal and maternal grand sires are about equal in production.

The actual productions of the females of the pedigree are of interest in showing that the dams' productions resemble those of their daughters rather more than those of the grandparents. The prominent selection of the paternal grand dams is evident. The maternal grand dams are relatively little selected. Their milk yields show a definite similarity to those of the grand daughter although this similarity is not so great as that of the dams.

Like pedigrees showing the sum total effect of inheritance on the butterfat percentage of the daughter are presented below. To form the low-testing pedigree we took 415 Jersey cows which had a butterfat test under 4.8 per cent. These cows came from tested dams and were by sires which had tested daughters. This group constituted about the lower sixth of the animals in the Jersey Registry of Merit. For the high butterfat testing group we took a group of 446 cows having a butterfat test above 5.9 per cent.

LOW BUTTERFAT PERCENTAGE

Daughters' butterfat percentage under 4.9 per cent	SIRE		PATERNAL GRAND SIRE
	Daughters' average butterfat percentage 5.18		Daughters' average butterfat percentage 5.32
			PATERNAL GRAND DAM
			Daughters' average butterfat percentage 5.26
			Average Paternal Grand Dam's butterfat percentage 5.16
			MATERNAL GRAND SIRE
			Daughters' average butterfat percentage 5.22
			MATERNAL GRAND DAM
	DAM		Daughters' average butterfat percentage 5.12
	Daughters' average butterfat percentage 4.99		Average Maternal Grand Dam's butterfat percentage 5.15
	Average Dam's butterfat percentage 4.96		

HIGH BUTTERFAT PERCENTAGE

	SIRE		PATERNAL GRAND SIRE
	Daughters' average butterfat percentage 5.51		Daughters' average butterfat percentage 5.41
			PATERNAL GRAND DAM
			Daughters' average butterfat percentage 5.42
Daughters' butterfat percentage above 5.9 per cent			Average Paternal Grand Dam's butterfat percentage 5.49
			MATERNAL GRAND SIRE
			Daughters' average butterfat percentage 5.42
			MATERNAL GRAND DAM
	DAM		Daughters' average butterfat percentage 5.56
	Daughters' average butterfat percentage 5.75		Average Maternal Grand Dam's butterfat percentage 5.55
	Average Dam's butterfat percentage 5.64		

These cows represented the highest testing animals in the Jersey Registry of Merit. They too constituted about a sixth of the animals tested and from tested dams. The pedigrees of these animals were run out to three generations. The average mature form butterfat percentage of the Registry of Merit daughters of each individual in these pedigrees was determined. These records were then averaged for each ancestral position in the pedigree. Besides this average, the average butterfat percentage of each ancestral group was determined for the female line of the pedigrees.

These typical pedigrees for cows of low butterfat percentage and for cows of high butterfat percentage display essentially the same general features as those seen for the milk yields. Throughout, the ancestors in the pedigree of the low butterfat tests have lower butterfat testing daughters than those of the high butterfat tests. Within either group the records of the parents are more nearly like those of their offspring than are the records of the grandparents. The butterfat percentages of the four grandparents are essentially the same within each group. No selective breeding for butterfat percentage is consequently practiced in the Jersey breed.

The data for the actual average butterfat percentages of the female ancestors in the pedigree show the significance of the ancestors closest to the animal under study as contrasted with the relative lack of importance of those a generation further removed. The average dam's butterfat percentage of the low line was 4.96 per cent, whereas that of the average dam in the high line was 5.64. The grandparents on the other hand show for the low line 5.16 and 5.15 per cent as their averages, whereas those of the high line were 5.49 and 5.50 per cent. It is obvious that the daughters resemble their parents' productions more closely than they do their grandparents. From other evidence it has been possible to show that the resemblance one generation further removed, the great grandparents, is even less. The data show that there has been no significant selection of bulls to be used as sires based on their dams' butterfat percentage. The effect of the paternal grand dam and of the maternal grand dam on the butterfat percentage of their grand daughters is clearly equal.

STUDIES ON GROWTH AND THE ANTI-RACHITIC VITAMIN.
W. Franklin Dove. *The Nutritive Value of Maine Fisheries Prod-*

ucts. Since the report of the discovery that Maine fisheries products are high in vitamin D content (W. F. Dove, Maine Station Bulletin 363, pp. 247-248) tests have been made to determine the effect of the degree of fatness of the fish, method of manufacture of the meal, and length of storage of the meal upon the vitamin D value.

The biological assays have been made under controlled laboratory conditions with the chick as the experimental animal. A standardized technic has been developed whereby the chick is on experiment during the most rapid growth period of its life, i.e., 3 to 11 weeks of age, during which time it may increase its weight tenfold and reach marketable size but only when the ration supplies the essential elements.

Under these conditions chicks may be raised even to sexual maturity with Maine sardine or white fish meal as the only source of animal protein, and without cod-liver oil or sunlight or any other source of vitamin D.

Fish meals produced by the vacuum drier retain their vitamin D potency for a longer time than fish meals made by the fire drier. Some fire-dried meals are high in vitamin D but they cannot be depended upon. The vacuum-dried fish meals, however, have always tested high in vitamin D and apparently retain the anti-rachitic factor after several years of storage. Two samples, now over two years in storage, are beginning to lose their potency. Usually a storage period of 12 months will cause a slight loss in vitamin D potency. As a rule the higher the fat the higher the vitamin D value of the meal. The percentage of fat in vacuum-dried meals affects the keeping qualities only slightly and only when kept for improbable periods of time. Vacuum-dried sardine and herring meals containing 15 per cent fat are generally higher in vitamin D than other meals lower in fat percentage. They will also keep for nearly a year without much loss in vitamin potency.

The Vitamin D Value of Maine Herring Oil. Preliminary tests made during the past two years indicate that the oil pressed from Maine sardine and herring is potent in vitamin D. In the past the methods of extraction have been adapted to the production of paint oil and not to the production of an animal food.

However, during the past year samples of oil have been secured from the fresh fish by pressure and without cooking. The

oils secured represent body oils as well as liver oils. They are not refined and for that reason do not test as high as they might test if secured under standardized conditions. But under these natural methods of production the crude unrefined Maine sardine oil is found to be protective at a level of one per cent in the ration.

In another way the results on the vitamin D in Maine herring oil substantiate the results secured in the biological assay of the sardine and herring meals: The higher the fat content the higher the vitamin D content. A meal containing 15 per cent of fat will, when fed as 12 per cent of the entire ration, add 1.8 per cent of an oil high in vitamin D and thereby cover the vitamin D requirements in rations for almost all classes of livestock.

Vitamin G in Maine White Fish and Sardine Meal Manufactured by the Vacuum Process. Preliminary tests made in the spring of 1933 indicated that the Maine fishery products of white fish and herring are potential sources of vitamin G. Basal rations lacking vitamin G supplements produced results comparable with the same rations containing the vitamin G in the form of yeast.

Maine Fish Meal for Dairy Cattle and for Swine. Maine fishery products manufactured by the vacuum process are palatable to both dairy cattle and swine as well as to smaller animals such as dogs and foxes.

In anticipation of an opportunity to carry out controlled experiments with dairy cattle preliminary tests have been made with a few calves. The eagerness with which they consume the sardine meals in concentrated form attests to the palatability.

Maine fish meal may rightfully be considered a highly desirable food for dairy cattle. One pound of fish meal a day will supply enough calcium and phosphorus for average milk production. Many dairy rations fail to provide enough calcium with the result of lower milk production and a depletion of calcium in the skeleton.

General observation indicates a lack of calcium in the rations of both dairy cattle and swine. Decreased milk production in dairy cattle and leg weakness in swine attest to the calcium deficiency. The Maine sunlight, low in ultra-violet ray, does not permit efficient use of the small amount of calcium supplied in the feed. Maine fish meal fed to dairy cattle and swine would supply these deficiencies of calcium and phosphorus and vitamin D and would also supply valuable proteins and "trace minerals."

IS THERE A GENERAL DEFICIENCY OF CALCIUM, IRON, AND MAGNESIUM IN MAINE SOIL? W. Franklin Dove. A large portion of the dairy cow's ration consists of home-grown forages: hay, root crops, and silage. Mineral deficiencies in the soil usually result in a mineral deficiency in the forage crops grown on the soil, which in turn may be reflected as similar mineral deficiencies in the animals subsisting upon these deficient crops.

In the absence of chemical analyses on home-grown crops, or upon Maine soils as a group, the mineral content of surface water or springs of vadose origin may serve to indicate mineral deficiencies in the soil they drain. All of the data published by the United States Geological Survey on Maine waters have been assembled and recalculated for this purpose. The results have been compared with data for surface water from the Great Lakes and St. Lawrence River basin and the Central West, all regions receiving approximately the same annual rainfall of 40 inches. The results show that Maine surface waters are below the average in calcium, magnesium, and, usually, in iron, but above the average in sodium and potassium. Magnesium deficiencies in both soil and crops have already been reported for Maine (J. A. Chucka, *Maine Station Bulletin* No. 363, p. 250). Similar tests for calcium and iron deficiencies on Maine soils have not as yet been made but the mineral analysis on the surface waters would indicate that the average Maine soil and the crops produced from it are deficient also in calcium and iron. The results of these deficiencies are probably more severe in pasture, hay, and other forage lands, which usually do not receive commercial fertilizer.

Dairy cattle, depending upon these forages low in calcium, are again deprived of the primary metal required for the production of milk. In at least three ways the Maine dairy cow may be deprived of calcium: Through the lack of the actinic rays of the sun which would conserve calcium or would make its utilization more efficient, through the probable deficiency in the calcium content of the Maine forages, and through the failure of the feeder to incorporate a high-calcium or vitamin D product in the dairy ration.

The addition of Maine fishery products to the ration would probably solve both the calcium deficiency and the vitamin D deficiency not only for the dairy cattle but also for other classes of farm animals.

PLANT BREEDING AND NUTRITION

POTATO FERTILIZER EXPERIMENTS. Joseph A. Chucka and Delmar B. Lovejoy. *A. Permanent Plots.* The 1933 results obtained with the various fertilizer treatments on the permanent fertility plots at Aroostook Farm are quite similar to the results of previous years. In general the potato tops were considerably smaller and total yields were somewhat lower than usual. Some magnesium deficiency symptoms in the potato plants were observed on the permanent plots and they appeared to be somewhat more pronounced on the plots receiving high analysis mixtures.

B. *Magnesium Deficiency Studies.* The study of the effect of magnesium in potato fertilizers was continued on five different farms in Aroostook County. Although the soils of none of the farms selected for this experiment this year were sufficiently deficient in magnesium to show magnesium deficiency symptoms, increases in yield due to the addition of magnesium were obtained on all farms. Considering only the average yields obtained on the five farms the increases in yield due to magnesium ranged from one to nine barrels per acre. Since four of the five farms produced total yields of over 160 barrels per acre and were therefore

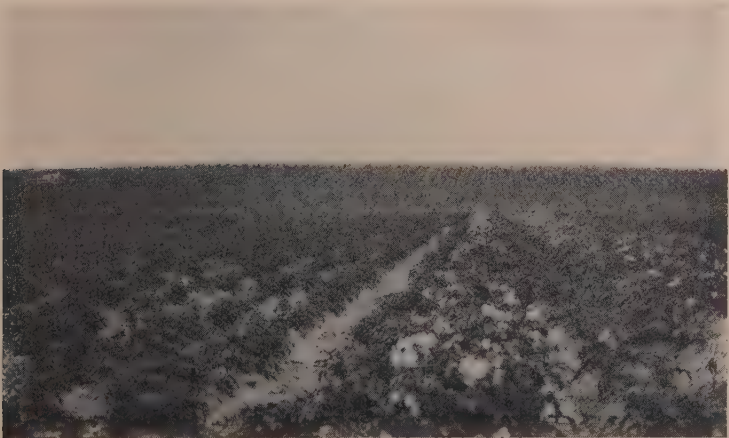


FIG. 146. A SEVERE CASE OF MAGNESIUM DEFICIENCY IN POTATOES

The rows showing an abundance of blossoms received fertilizer with magnesium.

in a much higher state of fertility than the average farm in Aroostook County it would seem logical to assume that practically all farms in Aroostook County will produce higher yields of potatoes if magnesium is added to the fertilizer.

The 1933 results with magnesium in potato fertilizers again indicate that 20 to 30 pounds of magnesium oxide per acre unit of fertilizer produce maximum increases in yield and that the soluble carriers of magnesium are more effective than dolomitic limestone as a source of magnesium in potato fertilizers.

In addition to the work with magnesium in potato fertilizers supplementary tests were conducted to study the effect of adding magnesium to the soil as a top dressing or to potato plants in the form of a spray after potatoes had developed definite magnesium deficiency symptoms. These applications were made during the first week in July which was two to three weeks after the plants had emerged. In all cases marked response to added magnesium was noted in five to ten days after the magnesium was added. The chlorotic (yellow) leaves did not regain their green color but no more chlorosis developed after the addition of magnesium and all of the new growth had a healthy green appearance. In the fall the untreated plants died early while the treated plants remained green until killed by frost.

The effect of the added magnesium on potato yields was surprisingly great as indicated by the results in Table 3. The results obtained by spraying magnesium deficient potatoes with Epsom salts are particularly interesting. In this experiment ten pounds of Epsom salts was added per 100 gallons of standard bordeaux mixture and the plot was sprayed six times during the season. Although only about one and two-thirds pounds of magnesium oxide was applied per acre in each spray a visible improvement in the appearance of the sprayed plants was noted within five days after the first spray was applied. This rapid response to such a small quantity of magnesium would seem to indicate that the plants were able to absorb the magnesium through the leaves. This possibility is further substantiated by the fact that single-stalk plants on the outside borders of the plot which were not entirely covered with spray showed a differential appearance between the portions covered and those not covered with magnesium spray.

TABLE 3

Effect of Magnesium Applied as a Top Dressing to the Soil and in the Form of a Spray to Plants After Severe Magnesium Deficiency Symptoms Had Developed in Potatoes

Farm No.	Year	Treatment	Yield barrels per acre		Barrels increase from Mg
			Untreated	Treated	
1	1932	Epsom salts	94	144	50
1	1932	Double sulfate			
		potash-magnesia	81	129	48
1	1933	Epsom salts	100	119	19
2	1933	Epsom salts	72	128	56
2	1933	Epsom salts sprayed*	81	132	51

*Ten pounds of Epsom salts per 100 gallons of bordeaux mixture in each of six sprays. All other treatments added as top dressing to the soil at the rate of 320 pounds per acre.

That is, the new growth on the portion of the plant sprayed with magnesium had a healthy green color while the new growth on the portion sprayed with standard bordeaux mixture still had a chlorotic appearance. If the magnesium were taken up by the roots one would expect it to be equally distributed through the entire plant.

Although the results of our magnesium deficiency studies show that magnesium deficiency in potatoes can be prevented in any one growing season by the addition of 20 to 30 pounds of magnesium oxide per acre unit of fertilizer and that it can very largely be corrected by top dressing or spraying with magnesium, both of these methods are necessarily only a temporary means of preventing magnesium deficiency. The most economical and most practical method of preventing magnesium deficiency is by the use of dolomitic (magnesium containing) limestone as a liming material. The proper use of dolomitic limestone as a liming material will not only supply the necessary magnesium for potatoes at a relatively low cost but will also tend to bring about a more favorable soil reaction and thus result in an increase in the yields of all crops grown in the rotation. By increasing the yields of clover and other green manuring crops the use of dolomitic limestone will tend to increase the organic content of potato soils and thereby increase potato yields beyond the increase due to magnesium alone.



FIG. 147. THE COMBINED EFFECT OF EXCESSIVE SOIL ACIDITY AND MAGNESIUM DEFICIENCY KILLS CLOVER ON THE OLD POTATO ROWS

Dolomitic limestone applied before seeding down will prevent this condition.

C. Ratios and Sources of Materials in Potato Fertilizers.

On the two farms where the 3-8-7, 4-8-7, and 5-8-7 formulas were compared, the 5-8-7 formula resulted in a somewhat higher yield than the other two. In 1932 the 4-8-7 gave the highest yield. On the same two farms the 4-8-7 formula outyielded the 4-4-7 formula. In a comparison of the 4-8-7 and 4-8-10 formulas a higher yield was obtained with the 4-8-7 on one farm and with the 4-8-10 on the other. These two formulas were compared on ten other farms during the past season. Of the twelve comparisons five were in favor of the 4-8-7 and seven in favor of the 4-8-10. However, in most cases the differences in yield were too small to be significant in favor of either formula. The average yield on the twelve farms was exactly the same, 152 barrels per acre, with the two formulas. As in other years the 4-8-10 formula outyielded the 4-8-7 on most of the lower yielding farms while the reverse was true on the higher yielding farms. Since it seems logical to believe that the soils of the higher yielding farms are higher in available potash it might be possible to distinguish between the farms that produce higher yields with seven and ten per cent potash by means of an analysis of the soils for available potash.

With regard to sources of materials in potato fertilizers the 1933 results substantiate previous work. A combination of two or more sources of nitrogen nearly always outyields any single source of nitrogen. A comparison of powdered and granular cyanamid indicates that the granular form is somewhat superior to the powdered form. However, neither form is desirable as a single source of nitrogen for potato fertilizers. A comparison of several sources of phosphorus in a 4-8-7 fertilizer mixture based on yields obtained indicates the following order of desirability as sources of phosphorus in potato fertilizers: superphosphate, ammoniated superphosphate, di-calcium phosphate, basic slag, precipitated tri-calcium phosphate, rock phosphate, and colloidal phosphate. Annuo phos was not included in this comparison but data from its performance in high analysis fertilizers indicate that it compares favorably with superphosphate as a source of phosphorus. In 1933, results with sources of potash in potato fertilizers indicate that there is little choice among muriate, sulfate, and nitrate of potash. A slightly higher yield was obtained with sulfate of potash but it is doubtful whether or not it is sufficiently superior to justify its higher cost.

The 1933 results obtained with the use of small quantities of high-calcium limestone as a filler in potato fertilizers substantiate previous findings, namely, that it results in a lowering of potato yields on soils deficient in magnesium unless sufficient magnesium is contained in the fertilizer to meet the requirements of the potato crop.

D. *Machine-Applied Potash Test.* Joseph A. Chucka and Delmar B. Lovejoy, in cooperation with Bailey E. Brown, United States Bureau of Chemistry and Soils. A comparison of the 4-8-5, 4-8-7, 4-8-10, and 4-8-12 formulas was made on three farms in Aroostook County. In this comparison the fertilizers were applied with the fertilizer attachment on potato planters rather than by hand as in the experiments discussed previously. The highest average yield was produced by the 4-8-10 formula, second with 4-8-7, third with 4-8-12, and lowest with 4-8-5.

E. *Uncommon-Element Test on Potatoes.* Joseph A. Chucka and Delmar B. Lovejoy, in cooperation with Bailey E. Brown, United States Bureau of Chemistry and Soils. In this study the same elements, namely, magnesium, manganese, copper, zinc, and

nickel, that were used in 1932 were again used in 1933. However, since some of these elements reduced the yields in 1932 their rate of application was reduced in 1933. The 1933 results indicate that copper and zinc as well as magnesium and manganese may have a stimulating effect if used in small quantities.

F. *Fertilizer Placement Studies on Potatoes.* Joseph A. Chucka and Delmar B. Lovejoy, in cooperation with Bailey E. Brown, United States Bureau of Chemistry and Soils, and G. A. Cunnings, United States Bureau of Agricultural Engineering. During the past season 4-8-7 and 8-16-14 fertilizers were placed in eight different positions with respect to the seed piece. The results obtained again indicate that the placement of fertilizer at the side of the seed pieces is in general superior to the placements above, below, or in contact with the seed pieces. These results are in agreement with the results obtained in New Jersey, Virginia, Ohio, and Michigan where similar tests were conducted.

GREEN MANURING CROPS FOR POTATOES. Joseph A. Chucka and Delmar B. Lovejoy. The winter of 1932-33 was unusually hard on medium red and manmoth red clover seedings. The clover stands on many Aroostook farms were completely killed and severe injury was reported on most farms in the County.



FIG. 148. BUILDING UP THE ORGANIC CONTENT OF AROOSTOOK SOILS BY PLOWING UNDER A FINE STAND OF CRIMSON CLOVER

There appeared to be somewhat less injury on the fields which had recently been limed. This appeared to be particularly true on a few fields limed with dolomitic limestone. The severe winterkilling of the common clovers has greatly increased interest in annual green manuring crops for Aroostook County as a source of organic matter for potato soils. Our results with annual green manuring crops again indicate that crimson clover, peas and mixtures of oats-peas, oats-peas-vetch, and oats-vetch-crimson clover are satisfactory annual green manuring crops for Aroostook County. Crimson clover appears to be particularly promising when cost of seed and total yield and quality of organic matter are considered.

GRAIN VARIETIES AT AROOSTOOK FARM. Joseph A. Chucka and Delmar B. Lovejoy. *Oats.* Six varieties of oats (Maine 340, Worthy, Gopher, Cornellian, Markton, and Minnesota Sinut Resistant) were grown in the grain variety test at Aroostook Farm. The yields obtained from highest to lowest were in the order in which the varieties are listed above and ranged from 82 to 58 bushels per acre.

Barley. Four varieties of barley (Alpha, Wisconsin No. 6, Wisconsin No. 38, and Velvet) were grown in the variety test. Of these Alpha gave the highest yield, Wisconsin No. 38 second, Velvet third, and Wisconsin No. 6 fourth. All of the barley yields were high, ranging from 54 to 65 bushels per acre.

Spring Wheat. Garnet, Marquis, and Red Fife were the three spring wheats grown in the variety test. All three varieties gave exceptionally high yields ranging from 32 to 40 bushels per acre. Garnet again produced the highest yield and Red Fife the lowest.

Winter Wheat. Minturki and Minhardi were the two winter wheats grown in the variety test. Both were so severely winterkilled that yields were not measured.

Winter Rye. Only one variety of winter rye was grown in the grain variety test. It was damaged only slightly by winterkilling and yielded 43 bushels per acre.

Flax. Bison and Red Wing varieties of flax were again included in the grain variety test. Bison yielded 20 and Red Wing 18 bushels per acre.

Canning Peas. Two varieties of canning peas, Surprise and Perfection, were planted at five different dates (at weekly intervals) at Aroostook Farm. Surprise was ready for canning a week to ten days earlier than Perfection. The color and flavor of peas of Surprise were inferior to those of Perfection. There was only a small difference in yield of shelled peas and of vines in favor of Perfection during the past season. In 1932 the yield of Perfection was considerably larger than that of Surprise.



FIG. 149. SMALL GRAIN VARIETY TEST AT AROOSTOOK FARM

FERTILIZER AND LIME TESTS WITH SWEET CORN AND BEANS. Joseph A. Chucka, Russell M. Bailey, and Delmar B. Lovejoy. The fertilizer and lime experiments with sweet corn and beans were continued at Highmoor Farm as started in 1931. Although the 1933 total yields of sweet corn were low, the differences in yields obtained substantiate in a general way the results of the past two years. Row applications of fertilizer resulted in greater increases in yield than broadcast applications. Row applications using more than 400 pounds of a 5-15-5 fertilizer were not profitable and none of the broadcast applications increased the yield of sweet corn sufficiently to pay for the cost of the fertilizer.

On the four-year rotation plots, the highest yields of sweet corn were obtained with chemical fertilizers plus lime and manure, second highest with chemical fertilizers and lime, third highest with chemical fertilizers and manure, and lowest with chemical fertilizers alone.

Lime applications of 1,000, 2,000, and 4,000 pounds per acre resulted in progressive increases in yield of sweet corn up to and including the 2,000 pound application. The 1,000 pound application, however, showed greatest returns.

Applications of 5-15-5 fertilizer in the row ranging from 100 to 700 pounds per acre resulted in progressive increases in yield of beans up to and including the 600 pound application. The average increase in yield obtained with the 600 pound application was 9.9 bushels per acre.



FIG. 150. THE HAND POLLINATION OF APPLES IS THE FIRST STEP IN THE PRODUCTION OF HYBRIDS WHICH MAY BE USEFUL

BREEDING NEW VARIETIES OF APPLES. Russell M. Bailey and Iva M. Burgess. Considerable progress was made on this project in 1933. About 2,000 new seedlings, representing 49 crosses involving the varieties McIntosh, Gravenstein, Wealthy, Greening, Delicious, Golden Delicious, Spy, Baldwin, and Cortland, were started in the greenhouse in the spring. These were moved direct-

ly to the nursery row in the field in June under very dry and unfavorable conditions. Wide differences in vigor and in uniformity of growth among the different crosses are apparent.

Fruits. Apples from seedlings of McIntosh X Spy, McIntosh X Delicious, and McIntosh X Golden Delicious are under test at the present time. A wide diversity of size, shape, color, and quality occurs in each of these crosses. Only a few hybrids appear worthy of much attention.

In connection with the breeding work a test of some of the new "red sports" of different varieties has been initiated. Scions of several red strains of Spy, McIntosh, Gravenstein, Duchess, and Stark were obtained and, along with scions of the parental variety as checks, were grafted into bearing trees at Highmoor Farm. The arrangement is such that the red strain of a variety can be compared with the parent, or standard variety, on the same tree at fruiting.



FIG. 151. CHEESE-CLOTH TENTS ARE USED IN APPLE POLLINATION STUDIES AT HIGHMOOR FARM

APPLE POLLINATION STUDIES. Russell M. Bailey and Iva M. Burgess. Artificial pollination studies in the apple were continued in 1933. This work, involving the most important Maine varieties, has been conducted over a four-year period. The results this year

substantiate the summary presented in the 1932 Summary Report of Progress, Bulletin 363. This year a considerable part of the work was done with the aid of cheese-cloth tents covering entire trees before blossoming. Previously, individual limbs were covered with the aid of mosquito netting cages. The type of tent used this year promises to be particularly good for such purposes. It



FIG. 152. GOLDEN DELICIOUS VARIETY

The blossoms of the branch heavily laden were pollinated with Wealthy pollen. The blossoms of the branch with the other card label were pollinated with Greening pollen.

consists essentially of a framework of semi-dry white maple saplings with a cheese-cloth blanket spread over the framework and held in place by strings encircling the cage at several levels.

BUD SELECTION IN THE APPLE. Russell M. Bailey and Iva M. Burgess. McIntosh trees at Highmoor Farm, which originated from budwood taken from "solid blush" and "striped blush" McIntosh several years ago have for three years borne the same types of apples as were produced on the parental trees. Scions from some of the younger trees of both strains have been grafted into a single tree to compare the two under the same conditions in the next asexual generation.

YIELD AND GROWTH OF APPLE TREES IN RELATION TO SHAPE. Russell M. Bailey and Iva M. Burgess. In this experiment the scaffold branches of alternate Golden Delicious trees of one row were tethered in a horizontal position each summer to produce an open type of tree. Care was exercised to prevent girdling effect by the strings. The other trees in the row were left to serve as checks. Data collected to the present suggest that in the early years of fruiting a significant increase in yield may be obtained in the open type of tree. In 1932 the mean yield of those tied down was 44.57 pounds and that of the checks was 25.17 pounds. Odds that the difference is significant are 115:1 obtained by "Student's" method of paired observations. In 1933 mean differences in yield were insignificant. Trunk diameter measurements taken in 1933 suggest that tying down the branches has resulted in reduced growth. Trees with tied down branches averaged 84.33 mm., whereas the checks averaged 89.33 mm. Odds that the difference of 5 mm. is significant are 50:1. It would appear that in a short time the check trees may be producing more fruit than those with tied down branches.

SMALL FRUIT VARIETY TESTS. Russell M. Bailey and Iva M. Burgess. *Strawberries.* Tests of the following varieties were conducted in 1933: Aberdeen, Bellmar, Beaver, Blakemore, Bliss, Bouquet, Gibson, Howard Supreme, Jupiter, Portia, Premier (Howard 17), and Wyona. Winterkilling occurred severely in all Bliss, Portia, and Bouquet plots. Howard Supreme and Wyona suffered less from winter injury than did the previously named varieties, whereas the remaining varieties were uninjured. Bou-

quet was particularly susceptible to mites, being the only variety exhibiting severe attack. Considering yield, berry characters, and winter hardiness, Premier (Howard 17) and Aberdeen appeared the most promising of the group. Aberdeen was not equal to Premier in berry flesh color or firmness but, because it fruits at a later date in the season and because of its many fine plant and berry characteristics, does offer promise for the home garden and for breeding material. Its berries, however, were too soft for shipping any great distance. Howard Supreme, when grown under conditions where it winters well, should prove a valuable berry because of its attractive, firm, high-quality fruit.



FIG. 153. THE STRAWBERRY VARIETY TEST PLOTS AT HIGHMOOR FARM

Raspberries. The varieties which were tested in 1933 were Latham, Chief, Viking, King, Herbert, and Lloyd George. Viking suffered severe winterkilling, resulting in very poor yield. Many of the plants of this variety also developed severe mosaic symptoms. Lloyd George winterkilled slightly, but produced a fair crop of large attractive berries. The fruit, however, was too soft for satisfactory shipping to any great distance. Herbert and King yielded heavily and were comparatively free from disease and winter injury, but produced a high percentage of crumbly fruit

which was unsuitable for market. Possibly these varieties were particularly susceptible to the drought conditions prevalent. Latham and Chief were the most promising of the group this year. Chief was several days earlier than Latham in ripening its fruit. The berries of the last two named varieties were medium in size and were attractive and firm enough for shipping. There appeared to be little difference in quality of fruit between these two varieties. Latham was superior to Chief in size of berry.

BREEDING INVESTIGATIONS WITH CANNING CROPS. Russell M. Bailey and Iva M. Burgess. *Sweet Corn.* An extensive yield trial of sweet corn varieties, double crosses and top crosses, was conducted again this year in connection with the breeding work. All double crosses grown gave an average increase in yield rate of 9.68 per cent over the average yield rate of five strains from the canners of Golden Bantam. The ten most promising hybrids yielded 17.8 per cent more than did the same five strains obtained from canners and were also earlier maturing. More uniformity of ear type and maturity was particularly pronounced in the hybrids. Considerable study was devoted to top crosses, in which hybrids obtained by crossing some of the best canners' Golden Bantam strains with promising inbred lines were under test.



FIG. 154. GREENHOUSE FACILITIES ENABLE THE GROWING OF TWO CROPS OF CORN IN ONE YEAR

Field Beans.

A. Old Fashioned Yellow Eye. Two strains of this variety, the runner type (State of Maine Yellow Eye) and an anthracnose-resistant bush type, were grown for comparison with the Red Kidney. The State of Maine Yellow Eye again showed its superiority over the bush type. An average yield of 36 bushels of dried beans per acre was obtained, which was the highest for all beans in the test plots.

B. Red Kidney. Five strains were grown. A Maine grown and selected strain was best in yield and type. One lot of California seed contained 22 per cent of an undesirable type of bean and was also infected with blight. The Geneva strain did not make as desirable a showing as in past seasons. The most noticeable result obtained was a reduction in yield of about 50 per cent where diseased seed was planted as compared with that obtained from clean seed with considerable infection developing later in the season. Of all the beans grown, Red Kidney was the most severely affected by diseases.

C. Pea Beans. Pea beans were rather severely attacked by true rust (*Uromyces appendiculatus*), some becoming defoliated. No anthracnose and but a small amount of blight was observed. The Emerson pea bean, developed at the New York Station, gave the best crop. This was the first season for growing this variety. Robust, which was previously the best producer, was in second place.

Snap Beans. Since white-seeded varieties of snap beans are preferable to those with colored seeds for canning purposes, three additional varieties with white seeds were grown in the test plots this year. Two of these, Hercules, a round green-podded sort, and White Seeded Wax, may have some possibilities for this purpose. Conserva continued to be a small producer. None of these, however, seemed to have as high quality as Brittle Wax (Round Pod Wax), Tendergreen (New Stringless Green Pod), Giant Stringless Green Pod, and Full Measure. The Refugees produced some good crops. Four strains of the stringless green Refugees were grown, but none showed any decided superiority over others. The Refugees have proved to be much more resistant to blight and anthracnose than other snap beans of equally good quality.

Disease free, or nearly disease free, progeny from the 1932 disease plot were grown in the greenhouse and were inoculated with spores of different strains of anthracnose. A few from crosses involving a certain parent were found to be resistant. The remainder of each of these crosses was planted in the field in a disease plot this season. Again, those appearing free from disease have been selected. Since one of the original parents was a snap bean, some may prove to be of value for this purpose.

GARDEN CROPS. Russell M. Bailey and Iva M. Burgess. The testing of the more important varieties of garden vegetables was continued in 1933.

In addition to the varieties recommended in Bulletin 363 several new varieties were included in the test. Of the varieties grown for the first time a few are considered worthy of mention. Emerald Standing Spinach was noticeable for its long standing ability. It was similar to King of Denmark in general appearance and in growing season. It remained in the field without bolting to seed for several days longer than any other variety.

Ohio Canner beet developed for the canning industry was very uniform in color and shape of root and in development. The roots were quite round and were dark in color like the Detroit Dark Red, and the tops were moderately heavy.

The Asgrow Emperor carrot seemed to be an excellent selection for market purposes. The roots were long, smooth, and quite uniform in type. There was little color differentiation between the core and outer part of the root.

A soy-bean to be used as a green shelled bean was found to be a vegetable of interest. Besides being desirable as a green vegetable the dry seeds compared favorably with our ordinary beans for baking purposes.

Lettuce. Twenty-six lots of New York lettuce were planted to study their adaptability to our growing conditions. A plot with different fertilizer treatments indicated that the earliest and the best heads were obtained with the use of a high phosphorus formula. Tipburn was also worse with this treatment. Whether this was due to the fertilizer or to a coincidence of weather favoring tipburn coming at the time when the bulk of the crop was coming to maturity could not be ascertained. There were some indications that the latter was the case.

None of the strains were entirely satisfactory from the standpoint of good head production and freedom from tipburn. The better ones were New York No. 12, New York Special, New York No. 5 and No. 4, Imperial F, Tipburn Resisting No. 484, and Tipburn Resisting No. 515. Imperial D was quite free from tipburn but failed to make good heads. The Tipburn Resisting strains No. 484 and No. 515 generally showed less of this malady than the other varieties. In early plantings, No. 515 headed fairly well, being quite similar in this respect to New York No. 5 while No. 484 did not do as well. In a later plot, however, No. 484 was better than No. 515.

Tomatoes. Particular emphasis was placed on the improvement of tomatoes and cucumbers. Twenty selections from Red River were grown in the test plots with other varieties. Some of them produced excellent early crops. Seven had produced at the rate of 2,000 pounds or more of marketable fruit per acre up to the middle of August while the best yield obtained from any of the varieties during this same time was 1,930 pounds per acre. In most of the selections the fruits were of good shape and color. They were to a high degree free from serious cracks. These early-producing plants were attacked early by blight thus suffering a reduction in total yield.

A study was made of the effect of staking and pruning on earliness. Six varieties were used and with the exception of Pritchard no appreciable increase in earliness per plant was obtained on the staked and pruned plants. However, the smaller space required for the trained plants permitted closer planting and thus increased the early yield for a given area. The cracking of fruits was much more severe on the pruned plants than on the unpruned.

Cucumbers. Cucumber scab (*Cladosporium cucumerinum*) has been a serious problem to cucumber growers in Maine for ten years or more. Breeding work to isolate resistant material was started in 1931 and has made substantial progress. Inbred breeding stock has been produced which exhibits a very high degree of resistance under severe field and greenhouse tests. These inbred resistant lines have continued to produce practically all scab-free fruits under conditions where such varieties as Boston Pickling, Chicago Pickling, and others have consistently given nearly 100

per cent infection. Unfortunately, however, the resistant breeding material is late maturing and is of the long, slicing type. Crosses with the pickling varieties have been made and F_1 plants are growing in the greenhouse to produce seed to aid the selection of F_2 plants in the field next summer.



FIG. 155. CUCUMBER PLOTS AT HIGHMOOR FARM WHERE A STUDY IS IN PROGRESS TO DEVELOP STRAINS RESISTANT TO SCAB

BLUEBERRY INVESTIGATIONS

FERTILIZERS. Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason. The fertilizer plots started in 1928 gave a greater increase in yield with the second application of fertilizer than was obtained with the first application. These studies show that nitrogen is needed most but a complete fertilizer gives the greatest increase in yield. On plots where there were no weeds before applying the fertilizer the increase in yield was sufficient to pay for the fertilizer added. A chemical analysis of berries from fertilized plots showed a slight increase in total acidity and non-reducing sugars while the reducing sugars were decreased. These changes were not great enough to alter the quality of the fruit. The blueberry plants on plots receiving two consecutive applica-

tions of six tons of lime per acre have not appeared to be injured and some of the weeds have decreased slightly in number.



FIG. 156. A "PATCH" OF BLUEBERRIES

Several nutrition experiments which have been conducted in the greenhouse indicate that nitrogen and organic matter should be increased in the blueberry soils.

SELECTION AND VARIETY TESTING. Frederick B. Chandler and Irvin C. Mason. A new planting was established in the spring of 1933 at Highmoor Farm to test native and introduced varieties of blueberries. These plants survived the dry summer very well.

POLLINATION AND STERILITY. Frederick B. Chandler and Irvin C. Mason. Work with honey-bees indicated that they increase the percentage set of fruit. Honey-bees should be used more extensively by blueberry growers as the natural pollinators are not plentiful enough to give an ideal set of fruit in seasons with an excess of cold, wet weather. Field observations on the length of time required for fertilization to take place showed considerable variation in varieties, some requiring about two days while others took more than four.

FIELD MANAGEMENT. Frederick B. Chandler and Irvin C. Mason. Experiments are in progress to determine the advantages

and disadvantages of burning in the fall every other year, fall every third year, spring every other year, and spring every third year.

WEED CONTROL ON BLUEBERRY LAND. Frederick B. Chandler and Irvin C. Mason. A series of plots was selected for a study of methods for controlling sheep's laurel. One-third of the plots were burned over every fall, another third every second fall and the remainder every third fall. Under each system of burning some plots were left without further treatment, others received fertilizer and still others received fertilizer and manganese sulfate. The use of fertilizer and manganese sulfate in combination with yearly fall burn showed some promise of laurel control. This treatment greatly reduced the vigor and resulted in a yellowing of the leaves of the laurel without apparent injury to blueberry plants. Although this method of controlling laurel would mean a loss of crop for one or two years, it might eventually result in profitable production on large areas of potential blueberry land which is now unproductive due to excessive laurel growth. Fall burning may serve also to control other low evergreen weeds which are competing with the blueberry for light and nutrients.



FIG. 157. THE FIRST BLUEBERRY FIELD DAY IN WASHINGTON COUNTY

An investigation of an economical method of controlling alders is in progress. A series of cuttings was made at intervals of every two weeks on three- and four-year-old stocks to see if there were a time in the year when new sprouts would not come up. So far cutting alone does not seem to be sufficient. In the same series of plots the stumps after cutting have been treated with substances very toxic to plants. Calcium chlorate is very effective for this kind of work but has a fire hazard. Sodium bisulphate is nearly as good and does not have the fire hazard. The crown of the plant may be entirely removed as a means of control. This requires twice as much labor as cutting but does not require any cost for chemicals and their application. Chemicals have the disadvantage of killing the blueberries in the immediate vicinity of the treated alders.

This year the sweet-fern plots indicated that cutting every year between the first of July and the middle of August gave the best control. Weed control seems to be one of the most important operations on blueberry land and therefore our studies will be continued and enlarged if possible.

CHEMISTRY

WORK OF INSPECTIONS. James M. Bartlett, C. Harry White, Bernie E. Plummer, and Glenn H. Perkins. The time of this department has been almost wholly occupied in making the analyses required by the Commissioner of Agriculture, who is the executive of the laws regulating the sale of foods and drugs, feeding stuffs, fertilizers, agricultural seeds, insecticides and fungicides.

Food and Drug Inspection. For this inspection three hundred and eleven samples were analyzed. The results were published in Official Inspections 147, a bulletin of 20 pages. Also 447 samples of milk and cream were analyzed for the Bureau of Dairy Inspection. These results were not published but were reported to the Chief of the Bureau of Dairy Inspection.

Dairy Glassware. Under the State law all Babcock glassware for testing milk or cream used by creameries, ice cream manufacturers, or other parties buying or selling milk or cream on a basis of the milk fat content are required to have all Babcock milk or cream bottles and pipettes used for the purpose tested for accuracy

by the Experiment Station. Nine hundred and eighty-four pieces were tested and all passed.

Feeding Stuff's Inspection. One thousand and sixty-two official samples were analyzed. An effort was made to get at least one sample of every brand sold in the State.

The results of the analyses were published in Official Inspections 148, a bulletin of 48 pages.

Fertilizer Inspection. Three hundred and sixty-five samples of fertilizer material were analyzed. The kinds of material and the results of the analyses are given in Official Inspections 149, a bulletin of 28 pages.

Agricultural Seeds, Insecticides and Fungicides. One hundred and twenty-three official samples of seeds were tested.

In addition to the above official samples 38 samples of various kinds of seeds sent in by farmers and dealers have been tested, making a total of 161 samples tested during 1933.

Eighty-two samples of insecticides and fungicides were examined. The results of the examination are given in Official Inspections 150, in conjunction with the results of the examination of agricultural seeds.

Gasoline and Motor Oils Inspection. The State Tax Assessor is the executive of the law regulating the sale of motor gasolines and oils and the Experiment Station is required to make the analyses.

Gasoline. Two hundred and sixty-four samples of gasoline were received and analyzed in 1933. Four samples were found to require a higher temperature for complete distillation (more than 437° F.) than allowed by the Statutes. Seven samples contained considerable sediment or dirt. Several samples marked ethyl did not have the characteristic red color which ethyl gas is supposed to carry; these were either substitutes or old gas from which the color had faded. The gasolines are, as a rule, lighter than formerly.

Motor Oils. Two hundred and ten samples of motor oils were examined. The motor oils are meeting their specifications much better than formerly or the dealers are more careful about handling them. Only two really bad oils were received. One was an oil that had evidently been used and the other was a poorly made oil. Twenty-six samples did not meet their specifications.

That is, they were not of the grade claimed. Frequently a medium oil was sold for a heavy or vice versa. In most cases they were good oils but not what the label claimed and in many cases probably the dealer was as ignorant of that fact as the buyer.

WORK OF INVESTIGATION. Elmer R. Tobey. The work of this department is cooperative with members of other departments and includes studies in the dairy projects; the determination of the amounts of spray residue on fruit; the analysis of soil, and fertilizer samples in connection with the problems of plant nutrition and of samples of feed used in the problems of nutrition and growth in poultry. The results of this work are included in the final published reports of the various projects.

ENTOMOLOGY

APHIDS. Edith M. Patch. Work has been continued in assembling data relative to the food-plant range of economic species of aphids.

APPLE FRUIT FLY OR RAILROAD WORM. Charles O. Dirks. The Federal authorities established a tolerance during the season of 1933 of .02 grain of lead and .01 grain of arsenic per pound of fruit for spray residues.

Analysis for Spray Residues. Samples of apples were gathered from a number of localities in the State and analyzed for spray residues. The data secured indicate: (1) apples sprayed with calcium arsenate retained, the last week of September, a residue one-fifth to one-tenth the amount of that present one month earlier while the corresponding fraction for apples sprayed with arsenate of lead was one-half. (2) All apples sprayed with calcium arsenate were safely below the tolerance on October 1 whether sprayed twice during July or three times during July and early August. On the other hand, the tolerance on October 1st was exceeded in practically all samples sprayed twice with arsenate of lead during July and by all apples sprayed three times during July and early August.

Control Studies. Various insecticides, including arsenical substitutes, were tested with apple fruit flies under laboratory conditions. These studies have shown that calcium arsenate killed

the flies more quickly than arsenate of lead. Promising results were secured with sodium fluosilicate, Paris green, nicotine tannate, and rotenone sprays.

Life History Studies. During the summer of 1933, fly emergence records were secured in six locations, Kennebunk, Cumberland Center, Monmouth (at Highmoor Farm), West Rockport, North Sedgwick, and Orono. The earliest emergence varied between June 23 at Cumberland Center and July 8 at North Sedgwick. The peak of emergence varied between July 6 at West Rockport and July 21 at Orono and North Sedgwick. Flies in small numbers continued to emerge in some locations during August but the bulk of the emergence (97-99%) was over by August 10 for all locations under observation.

The spray program is based upon the time and extent of fly emergence. Variety of apple and type of soil, as well as locality, were observed to influence the time of emergence and extent of emergence.

Data upon three different species of parasites (*Opius ferrugineus* Gahan, *Opius melleus* Gahan, and *Opius lectus* Gahan) of the apple fruit fly were obtained in 1933. *Opius ferrugineus* is the most abundant of the three species. These wasp-like parasites begin to appear after the peak of fly emergence and continue to appear during August. Our studies have shown that some of these parasites spend two winters in the ground in the fly pupae. Such two-year cycle parasites emerge the second summer shortly after the majority of the two-year cycle flies have emerged.

Less than one parasite to each 10 flies has been secured. The parasites deposit their eggs in or near the fly larvae while the larvae tunnel in the flesh of the apple.

INSECTS AFFECTING THE BLUEBERRY. Charles O. Dirks and Irvin C. Mason. In order to time to advantage the application of dusts for the control of the blueberry fruit fly, it is necessary to know the dates and extent of fly emergence. Investigations on this point are being conducted in several parts of the State where blueberries are of commercial importance. The following data present a summary of fly emergence for 1933.

Location	Date first flies appeared	Period of heavy fly emergence
Kennebunk (York Co.)	June 20	June 28 to July 11
North Whitefield (Lincoln Co.)	June 28	June 29 to July 15
West Rockport (Knox Co.)	June 28	June 30 to July 11
North Sedgwick (Hancock Co.)	June 25	June 28 to July 10
Deblois (Washington Co.)	July 1	July 6 to July 19
Tracyfield (Washington Co.)	June 28	July 4 to July 18

Several county agents and other individuals have cooperated in the securing of this information.



FIG. 158. FIELD DAYS AT AROOSTOOK FARM ARE WELL ATTENDED

WIREWORMS. John H. Hawkins. Of the 35 species of wireworms occurring within the State but about 10 are known to be troublesome to field and garden crops. Of these, the wheat wireworm, *Agriotes mancus* Say, is the most injurious species. Wireworms of the genus *Melanotus* affect crops in relatively light soils especially in the western and southern sections of Maine. Injuries

of a lesser nature are done by wireworms belonging to the genus *Ludius*. The so-called eastern field wireworm, *Limonius agonis* Say, is occasionally found to affect cultivated plants, and those of *Cryptohypnus abbreviatus* Say and species of the genus *Hemicrepidius* also affect crops in a minor degree.

The importance of cultivation as a control measure was again verified. Wireworms infesting plots during 1931 and 1932 were sufficiently reduced in numbers by 1933 so that potatoes dug before September 15 were mostly uninjured. This is of interest to potato growers since a large per cent of the potatoes in these plots were severely damaged during the two previous seasons.

Early digging of potatoes from soil infested by wireworms is important in minimizing the amount of wireworm injury to the tubers. Potatoes dug on September 7, 1933, showed a smaller per cent of tubers injured, a lesser depth of injury, and a correspondingly smaller area of injury on the tubers than did potatoes dug during October.

Eleven experimental plots, which were practically free from wireworms when they were seeded to oats and timothy in 1930, became reinfested while in timothy. These plots were plowed in the fall of 1932 and planted to potatoes in 1933. Potatoes in five of eleven plots were so badly injured that they had little value when dug.

Experiments with naphthalene for the control of wireworms during 1933 indicated that when used in the soil at the rate of from 300 to 600 pounds per acre it did not materially affect the yield of potatoes. Kainit was used in amounts varying from 300 to 1,000 pounds per acre. The effect of naphthalene and kainit on wireworm populations during 1933 is difficult to evaluate because of the reduction of the populations in all plots regardless of treatment. This indicates the probability that cultivation and natural causes were contributing factors to wireworm reductions in all the plots. A predaceous dipterous maggot of the family *Therevidae* was present in large numbers in the plots and may have been a factor in the reduction of the wireworm population. Further experiments with naphthalene and kainit are needed.

Common salt (NaCl) up to 1,000 pounds per acre produced no apparent effect on wireworms in the soil, upon the potato plants, or upon the yield of potatoes. These results are significant because certain farmers have used salt with the expectation of wireworm

control. Laboratory tests on the effect of salt on wireworms indicate that the amount of salt required to effect control would probably be injurious to growing vegetation.

Hydrated lime, quick lime, and calcium chloride used in field experiments for wireworm control apparently did not reduce the number of wireworms in the 1933 experimental plots.

Calcium cyanide used effectively as a soil fumigant for wireworms during the summer was tested for its effect on wireworms during the spring. Previous conclusions that calcium cyanide is not an effective soil fumigant under ordinary spring conditions in Maine were verified. Calcium cyanide, and the other substances tried during 1933, which add to the expense of crop production, can not be recommended at present.

Graham flour dough sweetened with honey was found to be attractive to the adults of the wheat wireworm, *Agriotes mancus* Say. It is not quite so attractive to these beetles as are the green stems and foliage of clover placed upon the soil. It has the advantage, however, of being available at any time that clover is difficult to obtain. Field experiments were conducted with substances for poisoning the adult wireworms after they were attracted to baits. Arsenious oxide, sodium arsenate, arsenate of lead coated with lead oleate, copper (basic) fluoride, Paris green, and calcium arsenate were used. The beetles were repelled by all these substances except arsenious oxide.

AROOSTOOK COUNTY POTATO SEED PLOTS AND MOSAIC.
Geddes W. Simpson. Experimental work on the project was continued during the season of 1933 in the same manner as previously reported.

During the season of 1933 thirteen seed plots located in ten different parts of Aroostook County were rogued regularly. Eleven of these were maintained for the purpose of producing foundation stock, while the two remaining were for the purpose of supplying seed for the production of table stock.

In one location in the northern part of the County, mosaic in excess of seven per cent appeared in the plot, necessitating its abandonment.

The results of roguing during two seasons are now available for three distinct localities. In each case the progeny of the original stocks, first planted in the County in 1931, are still being main-

tained. In another location the results of a single year's roguing are available. In 1933 plots were established and rogued in seven additional locations. The establishment of these plots offered an opportunity to include other varieties than the Green Mountain which was the only variety tested during 1931 and 1932. The varieties Cobbler and Katahdin were included in the work during 1933.

Of the plots which have been maintained for three seasons with the same stocks, one showed a decrease in both mosaic and leafroll content although neither disease was eliminated. In 1933, in this plot which contained 3,469 tuber units, but four units of mosaic and two of leafroll were found and rogued. Another plot in its third season in the County showed no increase in mosaic content, but did show an increase in leafroll amounting to one-half of one per cent. However, the total disease content of this plot is still less than one per cent. A third plot, in the midst of a commercial potato area, showed a considerable increase in mosaic, from 1.7 per cent in 1932 to 3.9 per cent in 1933, and also, a moderate increase in leafroll in spite of careful roguing. It is obvious that it is not worth while to continue this as foundation stock.

The plot which was first rogued in 1932 was planted with two different strains of Green Mountains. One of the strains showed a slight increase in mosaic in 1933 and the apparent elimination of a slight infection of leafroll. The other strain showed a decided decrease in mosaic with no variation in the leafroll content.

Just before the first inspection of fields entered for certification, a survey was made of a number of fields planted with stock raised commercially by certain of the growers cooperating with the Experiment Station on this project. In no case was the mosaic content of these fields, as determined by a count of 2,000 or more hills at random, in excess of one-half of one per cent. This was the first season that Aroostook foundation stocks grown in connection with this project have been planted in any amount. These results are evidence in support of the contention that foundation stock can be maintained commercially in certain localities in the County if adequate care is taken by the grower.

The use of indexed stock appears to be of value in the building up of disease-free strains. In thirteen attempts in small plots, ten plots have been found to be free from leafroll and eleven free

from mosaic. The practice is not infallible, but for practical purposes it undoubtedly has a place in the program of better seed production. The progeny from three of these plots grown during a second season have remained free from leafroll and in two cases the mosaic content has been limited to a single tuber.

Field notes on the relative abundance of the aphid species particularly involved in the spread of virus diseases in Maine yielded additional data on the distribution of these insects in relation to the results obtained in the various seed plots under test.

Small numbers of the aphid *Macrosiphum solanifolii* reared on potatoes infected with mild mosaic were transferred to healthy potatoes grown in cages. These transfers were made during the latter half of the season in order to study the effectiveness of this aphid in late season transmission of mosaic. The progeny of these caged plants grown in 1933 showed that under the conditions of the experiment no transmission took place although it is known that under favorable conditions the aphid may transmit the disease.

HOME ECONOMICS

ELECTRICAL COOKERY. Merna M. Monroe, Pearl S. Greene, and Lolie Smith. In the study of the relation of the physical qualities of utensils to their efficiency in electrical cooking, an outstanding factor in the use of a commercially flat-bottomed pan on a closed unit was found to be the area of contact between the pan and the hot surface. The height of sides on a utensil used for surface cooking has no appreciable effect on its thermal efficiency, but sides on a baking sheet retard browning.

In the management of the electric range there is an opportunity to reduce the cost of oven operation for certain processes by using the top unit for a part of the baking period.

Baking performance tests are being made in some inexpensive, non-insulated, low-wattage ovens, which bake principally by radiant heat from above and by conducted heat from below. The cost of operation for short-time processes ranges from 50 to 70 per cent less than that of the standard, well-insulated electric oven. Because these ovens are small, but small quantities of food may be baked at one time, and because of their construction no means is provided for controlling temperature. Tests show that certain

types of flour mixtures are better adapted to these new methods of heat transfer than are others.

FAMILY FINANCING OF HIGHER EDUCATION. Pearl S. Greene. A study of the methods by which Maine families finance their children at the University was begun last summer. Data were collected from approximately a hundred families in rural districts, villages, and cities in seven counties, and in some families cooperation was secured in the keeping of household accounts for one year, to show the relationship between the expenses for education and other items in the family budget.

COOKING QUALITY OF POTATOES. Marion D. Sweetman and Pearl S. Greene. Further work on the properties of potato starches and their relation to cooking quality is in progress. Tests on "gels" (solidified starch pastes) made from a series of potato starches which varied widely in viscosity and in volume of gelatinized material in dilute suspensions show comparatively little variation in "gel" strength. Studies comparing these properties of starch in distilled water suspensions with behavior in potato juice suspensions are now being carried on in the effort to ascertain causes for the differences in cooking qualities including mealiness.

PLANT PATHOLOGY

POTATO DEGENERATION DISEASES. (In cooperation with E. S. Schultz, W. P. Raleigh, F. J. Stevenson, and C. F. Clark, of the Division of Fruit and Vegetable Crops and Diseases, United States Department of Agriculture.)

Tuber Lines Free from Latent Mosaic. W. P. Raleigh. In 1932, 100 seed tubers of each of ten different Green Mountain strains representing ten different localities were obtained from Maine, Vermont, and Canada. Inoculations from the resulting plants were made on jimson weed (*Datura Stramonium*) which manifests latent mosaic by distinct mottling. The inoculations showed that only a fourth of the tubers in only one strain were free from latent mosaic. Some of the truly healthy plants, though planted in tuber units, became infected with latent mosaic so that their progeny in 1933 were partly infected. Apparently the Green Mountain variety is to be classed with a number of tested seedlings

which are quite susceptible to field infection by this disease in northeastern Maine.

Effect of Virus Diseases on Yield. E. S. Schultz, Reiner Bonde, and W. P. Raleigh. Tests of the effect of virus diseases on yield gave the following results in northeastern Maine in 1932.

Test	Variety	Disease	Plots	Plot size	Yield reduction
1	Green Mountain	Leafroll	6	46 hills	75%
	Katahdin	Leafroll	6	46 hills	56%
	Green Mountain	Spindle tuber	6	46 hills	31%
	Katahdin	Spindle tuber	6	46 hills	34%
2	Seedling 41956	Mild mosaic	10	50 hills	29%
3	Green Mountain	Mild mosaic	6	35 hills	12% by Aug. 6
	Green Mountain	Rugose mosaic	6	35 hills	57% by Aug. 6
	Green Mountain	Leafroll	6	35 hills	92% by Aug. 6
	Green Mountain	Spindle tuber	6	35 hills	52% by Aug. 6
	Green Mountain	Mild mosaic	6	35 hills	27% by Aug. 23
	Green Mountain	Rugose mosaic	6	35 hills	74% by Aug. 23
	Green Mountain	Leafroll	6	35 hills	80% by Aug. 23
	Green Mountain	Spindle tuber	6	35 hills	38% by Aug. 23
	Green Mountain	Mild mosaic	6	35 hills	29% by Sept. 14
	Green Mountain	Rugose mosaic	6	35 hills	76% by Sept. 14
	Green Mountain	Leafroll	6	35 hills	76% by Sept. 14
	Green Mountain	Spindle tuber	6	35 hills	38% by Sept. 14

Test 3 showed that the two mosaics reduced the yield rate more toward the end of the growing period than in the beginning while leafroll and spindle tuber reduced it more during the first part of the tuber-forming period than later. In other data from this test the relationship by weight of tubers to tops at different dates showed that in August the two mosaics and spindle tuber increased the tuber yield per unit weight of tops while leafroll reduced it.

Resistance to Virus Diseases. E. S. Schultz, F. J. Stevenson, C. F. Clark, Reiner Bonde, and W. P. Raleigh. Exposure to infection in the field in 1931, with results apparent in the second generation of plants in 1932, resulted in most of 727 small lots of seedlings contracting less mild mosaic than the Green Mountains used as controls. In 1932, 126 seedlings were tuber-grafted on mild mosaic plants of a seedling (41956) which did not harbor

latent mosaic. Here about a third of the tested seedlings remained apparently mosaic-free, some became like mild mosaic Green Mountain plants, and most developed mosaic symptoms with less distinct mottling than those on mild mosaic Green Mountain plants.

Seed Plots in Northeastern Maine. E. S. Schultz, Reiner Bonde, and W. P. Raleigh. In 1932 a certain stock of Green Mountains was grown on Aroostook Farm on a 1.5-acre tuber-unit seed plot for the fifth consecutive year. Isolation from other potatoes had been by about 1,000 feet the preceding year. The percentages of disease for 1931 and 1932 respectively were 1.8 and 4.3 for mosaic, 0.6 and 0.3 for leafroll, and 0.1 and 0 for spindle tuber. Other smaller seed plots in the vicinity were located in commercial fields and in clearings in the woods. Mosaic percentages for 1931 and 1932 respectively for different plots were 0 and 4.4, 0 and 2.3, and 2.9 and 0. These were isolated from other potatoes by 500 to 800 feet. Spindle-tuber percentages for the two years for a Katahdin stock were 24 and 0.4. Evidently mosaic can increase while spindle tuber is being eliminated.

Natural Dissemination of Virus Diseases in Northeastern Maine. Reiner Bonde. Studies in 1932 regarding the dissemination of virus diseases confirmed our former contention that spindle tuber and leafroll are much less readily disseminated than mild mosaic in the vicinity of Presque Isle. Healthy Green Mountains grown adjacent to mild mosaic in the field in 1932 were 46 per cent diseased when grown in 1933. Healthy plants 14 rows (40 feet) removed from mild mosaic became 12 per cent diseased. These facts indicate how generally mild mosaic was disseminated in Aroostook County. Rugose mosaic on the other hand was disseminated much less, adjacent healthy rows developing only 12 per cent disease in their progeny the next year. Here practically no spread occurred beyond the first row.

Healthy stock grown one row from leafroll in 1932 was 12 per cent diseased when grown in 1933. This disease apparently was not spread beyond the sixth row in our proximity studies. It is felt that one of the chief reasons that some growers have had difficulty in eliminating leafroll is that they have failed to detect and rogue the larger plants having the disease. These larger plants affected with leafroll easily escape notice, especially if the source of the seed stock is not planted in tuber units.

In 1932 spindle tuber was not spread beyond the first row where only 7 per cent of the plants became affected. The available data indicate that the chief reasons that some growers have not eliminated this disease are inexperience in detecting the symptoms in the field and failure to rogue the disease plants from the seed plots. At Aroostook Farm, seed plots of the Katahdin and Chippewa varieties were practically freed from spindle tuber in one season by rigid roguing practices followed by hand digging.

A few growers have had considerable difficulty eliminating "giant hill" from their seed stock. This trouble according to our proximity studies spreads very little if at all under field conditions and is easily removed by roguing. Growers should rogue their seed plots very carefully late in the season, if possible just prior to the first killing frost, and remove all the large late-maturing tuber units.

Seed Plots in Southwestern Maine. Donald Folsom. On Highmoor Farm, in 1932, Green Mountain tuber lines 301, 302, and 303 were still free of mosaic, but 303 showed 0.05 per cent in 1933. Lines 301 and 302 had about 2 per cent leafroll in 1932, while in 1933 there was more in 301 and only 0.2 per cent in 302. Lines 301 and 302 had no yellowtop in 1932 but had 0.1 per cent



FIG. 159. LARGE INSECT-PROOF CAGE BEING BUILT TO PROTECT SEED POTATOES FROM LEAFROLL, MOSAIC, AND OTHER VIRUS DISEASES FROM OUTSIDE THE PLOT

in 1933. Apparently mosaic spread half a mile or more, and yellowtop over a quarter of a mile, from other potatoes, while the effectiveness of roguing leafroll varied with the location of plots only a few hundred feet apart.

Another tuber line, No. 10, older than the preceding three, in 1932 in 2 acres on Highmoor Farm contained 0.1 per cent leafroll, no yellowtop, 0.05 per cent mosaic, and 0.3 per cent spindle tuber. This line was planted in 1933 in 20 different plots and fields, containing about 200,000 hills of which 0.05 per cent were leafroll, 0.03 per cent yellowtop, 0.01 per cent mosaic, and 0.05 per cent spindle-tuber. Apparently yellowtop had spread a half-mile to this field, while there was much improvement with respect to mosaic and spindle tuber. Of a total of 16.5 acres planted, 10.2 acres in 15 places were free of mosaic, and 6.3 acres in 5 places contained only 23 mosaic hills.

Components of Potato Mild Mosaic. E. S. Schultz, Reiner Bonde, and W. P. Raleigh. Mild mosaic, manifested by irregular light green spots and by slight wrinkling on Green Mountain potatoes, has been found to consist of two components. These components are a latent one that is masked in the variety Green Mountain as well as in many other varieties, including a Green Mountain seedling; and a second component, manifested on a seedling potato resistant to the latent component and on a latent-free Green Mountain seedling by light green and slightly rugose leaves.

The second component has been separated from the latent component by means of aphids, which transmit the second but not the latent component. It also has been separated by means of a seedling potato, which takes the second but is resistant to the latent component.

Inoculating healthy Green Mountain seedlings with both of these components produced typical mild mosaic. Moreover, inoculating Green Mountains harboring the latent component with the second component yielded mild mosaic.

EFFECT OF POTATO SPORT AND PLACE OF GROWTH AND STORAGE ON YIELD OF TUBER LINE. Donald Folsom. A Green Mountain tuber line was originated in 1927 as an isolated tuber unit. In 1930 one tuber unit of this line was mostly a sport, with peculiar foliage. Since then, the sport was multiplied and each year part reverted to the normal form. In 1933 a replicated comparison

was made of the yield rate from the original tuber line, the sport, and the part of the sport line that had reverted to normal. With the original line yielding 129 barrels (355 bushels) an acre, the sport reduced the yield 18 per cent (with odds significant) while the reversion differed from the original line only two per cent (with odds not significant). In comparison with the original stock grown at Highmoor Farm, referred to above, another part of the original line, grown at Aroostook Farm in 1932, in this test in 1933 yielded 8.5 per cent less (with odds not quite significant). Part of the Highmoor Farm grown stock stored at Highmoor Farm at about 35° F. with apples, yielded only two per cent differently from another part stored at Aroostook Farm in a potato house. Evidently sporting in this case had a marked effect on yield but the effect disappeared with reversion to the normal form, while place of growth seemed to have more effect than place of storage. This suggests the possibility of yield sports and that the effect of place of growth on seed stocks may be in favor of southwestern Maine.

POTATO ROTS IN TUBER-BRUIISING STUDIES. Donald Folsom. In the fall of 1932, members of the Department of Agricultural Economics stored several dozen sacks of potatoes in as many different bins in Aroostook County. At an examination made about December 1, the writer was present and selected tubers representative of various kinds of injury as judged by the eye. These tubers were kept for a week in a warm cellar, and then for four months in a cool apple cellar where sprouts did not form, whereupon attempts were made to isolate fungi.

Certain lesions were suspected of being caused by *Phoma tuberosa* and yielded that fungus. However, it was obtained also from lesions of other kinds and from "bruises." ("Bruises" apparently included both crack-forming contact injuries and blotches, without cracks, just under the skin at places on the tuber where bumping would be common.) *Fusarium* of a certain type was obtained from several lesions and likewise *Alternaria solani*. No other fungus was at all common, only one culture was bacterial, and about a third of the cultures were sterile. Considering the ease with which fungi were secured from obvious rot lesions, the high proportion of sterile cultures probably was due to their being involved with pure bruises. If this is correct, there are sterile

bruises that can not be distinguished from fungous lesions or fungus-invaded bruises except by culturing.



FIG. 160. BOXES ARE BEING TRIED AS STORAGE CONTAINERS

The potatoes are picked and stored in the boxes thus avoiding much of the rough handling incidental to methods now in general use.

Each of the three pathogenic fungi mentioned was found in nearly all of the different samples, indicating a general distribution of these fungi. Only two samples were characterized by the prevalence of any single fungus. None of the lesions or bruises changed perceptibly during the four months in cool storage, except perhaps some due to *Fusarium*. It may be concluded that even official inspectors can not classify many defects properly without culturing them, but nevertheless they probably would be correct in reporting both "bruising" and rots caused by *Fusarium*, *Phoma*, and *Alternaria*, from almost any Aroostook lot of potatoes.

RESISTANCE OF POTATO SEEDLINGS TO LATE BLIGHT. F. J. Stevenson, E. S. Schultz, C. F. Clark, Reiner Bonde, and W. P. Raleigh. The 727 seedling lots tested for resistance to mild mosaic, were not sprayed and in 1932 were exposed also to an epidemic of

late blight which killed all leaves and stems of 54 Green Mountain control lots by early September. At this time six seedling lots, all progeny of naturally fertilized Katahdin seed, manifested only a few blighted leaves per hill.

YIELD COMPARISONS BETWEEN GREEN MOUNTAIN, GIANT HILL, AND FOSTER SEEDLING OR RUST PROOF POTATOES. Reiner Bonde. In 1931 and 1932 the Green Mountain variety was compared with Giant Hill (a Green Mountain disease, sport, or admixture) and Foster Seedling under very severe late-blight conditions. The results definitely show that Foster Seedling is highly resistant to late blight both in the foliage and the tubers. The fact that the late maturing Giant Hill blighted badly, indicates that resistance is not due entirely to lateness. It is probable, however, that resistance to late blight is linked with lateness of maturity, inasmuch as no definitely resistant early maturing variety is known.

In 1933 the same stocks were tested under practically disease-free conditions. The average yields (barrels per acre) based on ten fifty-foot replications are as follows:

Green Mountain	130
Giant Hill	129
Foster Seedling	117

Although the Foster Seedling here gave an inferior yield, its yield can be greatly increased by planting early, spacing further apart in the row (possibly 14-15 inches), and applying additional fertilizer. This variety sets very heavily and requires greater space and fertility for maximum yields.

SOIL DISINFECTION FOR POTATOES VS. RHIZOCTONIA. Donald Folsom. In the greenhouse, corrosive sublimate 1-2,000 as a soil-soak was completely effective against *Rhizoctonia mycelium* and lesions on potato stems whereas 40 per cent formaldehyde 1-100 and acetic acid 1-100 had little effect. In the same experiment, with but little damping off in cabbage, cucumber, and tomato, these plants were injured by corrosive sublimate and generally started better with formaldehyde used than with acetic acid or no treatment.

POTATO SPRAYING AND DUSTING. Reiner Bonde. The spraying experiments reported here were all conducted with the Green

Mountain variety. The season of 1933 was extremely dry and characterized by an absence of potato late blight or "rust." This is a great contrast with the past three seasons when the disease was exceedingly abundant and caused great losses. The absence of late blight made the results from these experiments less interesting. Valuable information was, however, obtained regarding the necessity of spraying during seasons in which disease is absent.



FIG. 161. LARGE TRACTOR-SPRAYERS ENABLE THE POTATO GROWER TO COVER ACREAGE RAPIDLY

The Value of Spraying Potatoes in the Absence of Late Blight or Potato Rust. It has been demonstrated that spraying potatoes is highly beneficial and economical during seasons of rust epidemics. The question is, however, does it pay to spray in seasons when rust is absent or not abundant? The season of 1933 was remarkable for the absence of disease and therefore afforded an excellent opportunity to obtain data relating to this question.

Yields obtained from plants that had been sprayed with Bordeaux mixture and with home-made colloidal copper respectively were compared with adjacent nonsprayed controls. During the summer six applications were made with a tractor-drawn power machine. Parts of each series of plots were harvested respectively at seven different times during the growing seasons. The aver-

age yields, in barrels per acre, for the treatments at the different dates were as follows:

Date harvested	Bordeaux mixture	Colloidal copper	Nonsprayed controls
Aug. 5	56	49	55
Aug. 21	74	69	77
Aug. 28	89	93	92
Sept. 8	119	120	122
Sept. 13	131	133	129
Sept. 20	140	138	131
Sept. 27	150	145	136

Each yield is the average for eight replicated 50-foot row plots. The crop was dug by hand and weighed in the field.

These data show that the yield was little influenced by spray of either kind until after September 8. Up to that date the unsprayed plots appeared to yield slightly more than those that had been sprayed. After September 8 the unsprayed plots failed to increase in yield as rapidly as did those that had been sprayed. Weights were also secured of the foliage for the different treatments at the dates of harvest. These data indicate that the weight of the foliage of the nonsprayed plots began to be lessened about the same time that the yield was affected. This decrease in weight of foliage was due largely to an abundance of flea beetles which fed more freely on the unsprayed foliage.

It is of interest that in these tests the plots sprayed with colloidal copper yielded less than those sprayed with Bordeaux and more than the unsprayed controls. Colloidal-copper spray was somewhat repellent to flea beetles but was less effective in this respect than Bordeaux mixture.

It is of special interest that the yield of the sprayed fields continued to increase quite rapidly until the plants were dead from old age, a fact not generally recognized by growers. The data show the importance of continued growth late in the season for maximum yields and also the benefits derived from the control of flea beetles. The results indicate that distinct increases in yield can be obtained by spraying in a season when rust is absent and that it may sometimes pay to continue the spraying operations until late.

The Delayed Spray Program. The Maine Experiment Station in recent years has recommended a delayed spray program for general use by farmers in Aroostook County. It has been learned that the first and second spray applications, formerly recommended as measures against flea beetles and early blight, can generally be omitted with no loss in yields. The writer therefore feels that the early spray applications made while the plants are small are largely wasted. It would be more practical to omit these earlier sprays and apply additional sprays later in the season if a need for them develops.

Following this practice, spraying was not commenced on Aroostook Farm before July 14 in 1933 when the potato plants were from 12 to 14 inches high. Ordinarily farmers would have made from one to three applications before that date if the old spray practice had been followed.

In order to secure more data on the value of the delayed spray program an experiment was conducted comparing our suggested spray program with a still more reduced spray schedule. In these tests both the horse-drawn and the tractor rigs were employed. Here the regular spray program as now recommended by the Experiment Station consisted of six applications and the delayed program of four applications, omitting the usual first two.

The yields (barrels per acre) secured in these comparisons are as follows:

Type of Machine	Regular Spray Schedule	Delayed Spray Schedule
Horse drawn	147	146
Tractor drawn	145	147

The data show that the plots receiving only four late applications yielded as well as did those receiving six applications. Therefore the two additional early applications employed in our regular spray program were largely wasted. Furthermore, many farmers would probably have applied from one to three applications before July 14 when the first one was made on Aroostook Farm.

Spray Service. The spray program as conducted on Aroostook Farm has been followed closely by many growers in Aroostook County. A spray service was started in 1931 under the direction of the local Farm Bureau aided by the Experiment Station.

The popularity of the spray service can best be estimated by its growth during the past three seasons. The number of growers who were enrolled as cooperators in this project for the last three years are summarized as follows:

Year	Number of cooperators enrolled
1931	81
1932	347
1933	2,410

The service involves notifying the cooperators when late-blight infection is first observed and sending them further statements as to the occurrence of weather conditions which favor the rapid spread of the disease. The cooperators also receive notices through the mail telling them each time when it is planned to spray on Aroostook Farm. The growers are not obliged to follow the spraying dates given on the cards. The cards do, however, give suggestions as to when the writer thinks it is advisable to make a spray application.

The spray service is probably of most value during seasons of rust epidemics. Great benefits are, however, also obtained in years of little disease. By following the spray service of 1933, the growers saved the cost of the first two spray applications of the season which would have given no benefits. The spray service also advised a late application which when followed gave quite a noteworthy increase in yield by reducing flea-beetle injury late in the growing season.

It is also of importance that the 2,410 farmers receiving the spray notifications were not the only ones who benefited from the project. In many cases the neighboring growers of those receiving the spray notification also were informed and used the information made available. This project has been well received and is performing a needed service to the growers of Aroostook County in giving them timely information on spraying problems and also in making the potato growers of the County more "spray-minded." That is, instead of spraying being a postponed drudgery it becomes an interesting study on the part of many groups of growers.

Effect of Decreasing the Lime in the Bordeaux Mixture Formula. In 1933 the 10-10-100 standard Bordeaux mixture formula was compared with a formula in which the lime content was reduced to one-half that commonly used. Also the 10-5-100 Bordeaux was applied only half as often as was the standard Bordeaux, by omitting the second, fourth, and sixth of the regular applications.

The yields (barrels per acre) for these comparisons are as follows:

Standard Bordeaux (10-10-100)	140
Reduced-lime Bordeaux (10-5-100)	145

The differences in favor of the reduced-lime formula appear to be significant (odds 44.87 to 1). The experiment has shown that the lime content sometimes can be reduced in the preparation of Bordeaux mixture without loss in yield.

High-Magnesium Lime vs. High-Calcium Lime in the Preparation of Bordeaux Mixture. The Aroostook potato farmer is greatly interested in the kind of lime he uses for spray purposes. In the past both he and the manufacturers have been largely concerned with the purity and the fineness of the lime used in making Bordeaux. The average farmer has demanded a spray lime that is very fine and that also contains a high percentage of calcium. Recent work has, however, shown that a high-magnesium lime (dolomitic lime) may be better on the plants grown in some Aroostook soils than is the more commonly used high-calcium lime.

In 1933, Bordeaux mixtures prepared respectively with the two kinds of lime were compared in spray experiments conducted on farms in the vicinity of Easton and of Limestone. The high-magnesium lime was distinctly superior in both of these places. The yields (barrels per acre) from these tests are as follows:

Location	Soil type	Calcium Bordeaux	Magnesium Bordeaux	Difference
Limestone	Poor	10	45	35
"	Better	92	105	13
Easton	Poor	24	56	32
"	Better	98	108	10

It can be seen from the preceding data that the yield was greatly increased by substituting magnesium for calcium in the Bordeaux. This increase in yield was most prominent on the poorer soil that had been depleted of magnesium and organic matter by heavy cropping and leaching. This would suggest that a magnesium Bordeaux will not give great increases in yields on the more fertile potato soils of Aroostook.

The work of this Station and reports from other states show also that Bordeaux mixture made with high-magnesium or dolomitic lime has good physical and fungicidal qualities.

Comparison of Bordeaux Mixture and Home-made Colloidal Copper Spray. Colloidal-copper spray was furnished to the writer by Dr. W. P. Raleigh whose method of making it was described in last year's report. This spray material has an advantage over Bordeaux in that its residue is invisible on potato leaves. Colloidal copper has been recommended largely for spraying seed plots where a spray residue that will mask the symptoms of mosaic is undesirable. In 1933, colloidal copper was compared with Bordeaux mixture in order to obtain additional data regarding its merits and practical value.

The yields for this series of tests are as follows:

Treatment	Yield per acre in barrels
Colloidal copper	139
Bordeaux mixture	137
Nonsprayed controls	134

It can be noted that the plots sprayed with colloidal copper yielded slightly more than did those receiving Bordeaux mixture. The amount of this increase is, however, too small to be of much significance in these tests and we are not justified in concluding that one spray was better than the other in this test. It was observed that Bordeaux was a better repellent against flea beetles than was colloidal copper, a fact that should be considered by growers. In practical use seed growers may find it advisable to spray with colloidal copper until the fall brood of flea beetles appears. At that time mosaic plants will have been rogued and Bordeaux mixture can still be applied for flea-beetle control if necessary.

Comparison of Home-mixed and Commercially Prepared Copper-Lime Dusts. In 1932, home-made copper-lime dust was found to control disease and increase yields about as well as the commercially prepared product. These two preparations were compared again in 1933 under practically disease-free conditions. The average yields (barrels per acre) for the two preparations based on 15 replicated plots per series were 127 for the home-made and 128 for the commercial. There was no significant difference between home-made dust and commercially prepared dust provided they contained the same amount of copper and were properly prepared.

Comparison of Bordeaux Mixture and Home-mixed Dust. Plots sprayed with Bordeaux mixture were compared with adjacent plots dusted with home-made dust. The yield rate (barrels per acre) from four replicated plots per series was 131 for the spray and 123 for the dust. This might indicate that the Bordeaux spray was somewhat superior to dust although the calculated odds are not significant.

Comparison Between Plots Dusted with Home-Mixed Dust and Nonsprayed Controls. It was possible to make a direct comparison between plots dusted with home-made dust and adjacent nonsprayed controls. Only four replicated pairs of plots were available for this comparison. The yield rate (barrels per acre) was 135 for the dust and 132 for the controls. The increase was too small to be considered significant.

SEED-POTATO TREATMENT. W. P. Raleigh and Reiner Bonde. In the seed-potato treatment experiments on Aroostook Farm in 1933 the standard corrosive-sublimate treatment was compared with the acid corrosive-sublimate treatment and various modifications of it and with mixtures containing corrosive sublimate and potassium iodide.

The untreated *Rhizoctonia*-infected Irish Cobblers produced a crop having less than 15 per cent of the tubers with sclerotia or black scurf. Most of the treated lots produced tubers with a very low percentage showing sclerotia but at that, the large differences of other years were not experienced since the check lots showed such a low percentage of infection.

The increase in yield due to treatment of the *Rhizoctonia*-infected Irish Cobblers was about four barrels per acre for the standard corrosive-sublimate and acid corrosive-sublimate treat-

ments. This is much less than usual. There was no significant difference in yield due to treatment of *Rhizoctonia*-free Irish Cobblers.

The acid corrosive-sublimate method as used for the past few years has given favorable results regarding the control of *Rhizoctonia*. In our experiments it has usually caused some pitting of the treated surface of the tubers but no serious injury has resulted from its use. However, this treatment when used by a few growers in Aroostook County in 1933 caused severe pitting of the eyes of the tubers in a few instances. Apparently this was due to the fact that the potatoes were not dried properly after treatment. Similar results have been reported from other sections of the country.

Due to an unusually dry period in August the potato tops in all the plots died prematurely so that the yield was reduced about 50 per cent as compared with yields obtained in our seed-potato treatment tests in previous seasons. It is probable that these unusually dry conditions affected the results regarding *Rhizoctonia* infection as well as the differences in yield.

COMMON SCAB OF POTATO. W. P. Raleigh. Potato scab was somewhat more general on Aroostook Farm in 1933 than usual. It did not appear to be as severe as usual in the very low places but in large areas surrounding these low places scab was very general and as a result the loss was much greater than usual.

Several seedling potatoes and a few commercial varieties were tested for resistance. They were planted in alternate hills with Green Mountains. One heavily russeted seedling potato continued to show marked resistance to scab.

APPLE SCAB CONTROL. Donald Folsom. Apple scab control was studied in three orchards on Highmoor Farm.

Twenty-year McIntosh Trees. In 1933 the two rows of 20-year-old McIntosh trees, 20 trees to a row, were used for a comparison of the standard one-nozzle spray gun with an eight-nozzle rod used from the top of the tank of the spray-wagon. Each method was used on an entire row. On June 25 only one-third of one per cent of the leaves examined were found scabby, these being restricted to the upper limbs and being equally divided between the two treatments. The eight-nozzle rod saved much time and material, more than on the smaller Golden Delicious trees referred to later. In both treatments less than one per cent of the apples

were scabby and less than three per cent were defective due to russetting. Neither kind of defect was significantly more abundant in barrel lots of one row than in those of the other. With the eight-nozzle rod there was slightly less scab and slightly less russetting. The yield in the eight-nozzle row continued its increase as a moving five-year average, somewhat faster than the other row, but trunk growth showed a decided comparative slowing-down in a corresponding average, probably because of the greater yield. Therefore if the one-nozzle gun reduced the yield, according to past trends the effect will merely be some reduction of the tendency to alternate bearing. Even so, the eight-nozzle rod is to be preferred for the other reasons indicated.

Small McIntosh Trees. In 1933 on the small McIntosh trees there were 64 tent-caterpillar nests on 50 trees. By treatments, there were 21 of the nests on check, 18 on lead-arsenate, 10 on lime-sulphur, 8 on sulphur-dust, 4 on border, and 3 on sulphur dry-mix, trees. Only 8 nests were in the 240 trees in the quadrangle formed by the 24 northeast plots, leaving 56 nests in the other 235 trees. The latter were all within about 170 feet from the infestations of 1932. Apparently the pest spread, but not much beyond this distance. In view of the severe effect upon growth shown in 1932, the pest was eliminated by applying lead arsenate early to all trees.

Flower buds were found on 24 per cent of the 370 original McIntosh, on none of the other McIntosh, and on 26 per cent of the trees of other varieties. Among the original McIntosh trees, there was a correlation with size of stem, as follows:

Stem circumference in cm.	3-7	8-12	13-16	17-20
Total trees	28	143	167	32
Trees blossoming	0	9	57	21
Trees blossoming % of total	0	6	34	66

Among the different treatments, there was a difference not due to any difference in stem size, as follows:

Treatment	Lead arsenate	Sulphur dust	Sulphur dry-mix	Untreated	Lime sulphur	Border
Total trees	68	65	69	75	68	24
Trees blossoming	23	21	22	16	2	3
Trees blossoming % of total	34	32	32	21	3	13

Apparently lime sulphur postponed the formation of blossom buds somewhat.

Fruits were found on 13 per cent of the original McIntosh trees on August 9. According to the different treatments the fruits were distributed as follows:

Treatment	Lead arsenate	Sulphur dust	Sulphur dry-mix	Untreated	Lime sulphur	Border
% of trees fruiting	27	18	15	5	3	5
No. fruits per tree	2.0	1.08	1.0	0.1	0.1	0.04

The number of fruits per tree was significantly greater for the lead-arsenate and dust series than for the untreated and lime-sulphur series. Although the number of fruits and the number of bearing trees are small, there is a definite indication that both lack of treatment and treatment with lime sulphur reduced or postponed the first fruiting.

As in previous years, lead arsenate caused the most necrotic spray injury to leaves and reduced leaf scab somewhat. The usual superiority of lime sulphur in leaf-scab control was shown except for the sulphur dust being significantly superior to the lime sulphur. The determination of trunk size was continued. Averages for the different treatments are as follows:

	Leaf examination August 9			Stem circumference (cm.)		
	Trees	Scab %	Burned %	Trees	Increase	Final
Sulphur dust	9	2	17	65	2.83	15.80
	8	3	23			
Sulphur dry mix	10	13	11	69	3.04	16.04
	9	15	16			
Dry lime sulphur	10	4	24	69	2.86	15.23
	9	6	20			
Lead arsenate	9	16	45	68	3.01	15.47
	9	27	49			
Nothing (checks)	9	29	11	75	2.80	15.08
	9	30	8			

In the preceding table the two figures on leaf examination for each treatment represent respectively all trees of plot 1, and tree 3 of each of the nine plots.

On September 26 the proportion of total leaves burned was estimated for each tree in tenths. Average results were 0.53 for lead arsenate, 0.21 to 0.13 for other treatments, 0.08 for border untreated trees, and 0.03 for untreated plot trees. The average for the lead-arsenate series was significantly higher than all other averages, and the average for untreated plot trees was significantly lower than all treatment-series averages. Trunk growth at this date, for the season, was about the same for all series of plots, and was at about the same rate as for recent years. Among the lead-arsenate series, as trunk size was greater, indicating better conditions for growth the last several years, the greater was the circumference increase for the year (r (correlation coefficient) = $+0.786 \pm 0.031$) and the less severe was the burning ($r = -0.562 \pm 0.056$).

Golden Delicious Trees. In 1933 several rows of rather young bearing Golden Delicious trees were given different treatments to see if fruit russeting could be reduced without a corresponding increase in scab. By June 26, four rows that had received the same lime-sulphur treatment to the calyx application inclusive, differed with respect to leaf scab. This variation of rows resulted in significantly less leaf scab being found August 9 in a row with no treatment after blossoming, than in two rows receiving sulphur dust and lead arsenate respectively after blossoming. In spite of this variation, it is concluded from the observations made August 9 that lime sulphur reduced scab and caused burning on the leaves similarly, whether applied with the one-nozzle gun or with an 8-nozzle rod. The latter saved time and material. Of the untreated leaves, 31 per cent were scabby. Lead arsenate applied after the calyx application increased leaf burning considerably, so that 39 per cent of the leaves were affected by it.

Lumped for each treatment, the apples showed:

Row	Treatment	Apples	% scabby	% russeted
7	None (checks)	1,419	62	31
1	Dry lime sulphur (4-50) with gun	1,943	2	30
2	Dry lime sulphur with 8-nozzle high-pressure rod	2,330	1	46
4	As preceding except nothing after calyx application	2,296	7	26
3	As preceding except only lead arsenate after calyx application	2,048	5	20

5	As preceding except only sulphur dust after calyx application	1,447	2	23
6	Sulphur-arsenate dust	981	4	37
1 & 3,	"Sulfospray" (1-300)	1,287	27	31
So. ends				

Lead arsenate was applied with the sulphur materials when necessary. The sulfospray was applied at the strength recommended by the Mac Sulphur Corporation, which supplied the material. The percentage of fruits scabby as given here did not include apples with scab symptoms consisting only of red spots. While scab infection was frequently apparent at the centers of red spots, such spots also were associated with insect injuries of different kinds. In the untreated series, 95 per cent of the apples were typically scabby, or red-spotted probably because of scab, or both. Russetting was counted if a fifth of the fruit surface was affected.

The fruits were examined in barrel lots, there being about 450 per barrel, to determine some of the variation within each row. In scab control, the 8-nozzle rod was slightly but significantly better than the standard gun. Scab was increased slightly and significantly by the substitution of sulphur dust for lime sulphur and by the discontinuance of lime-sulphur spraying after the calyx application, with or without other materials being used thereafter. Sulfospray was not effective at the strength used. About a third of the fruits were russeted in the untreated check row. Compared to this, there was a significant decrease of russetting in the row receiving only lead arsenate after the calyx application, in spite of the considerable amount of leaf burning, noted above. The row receiving lime sulphur through the 8-nozzle rod had significantly, and considerably, more russetting than every other row. From the standpoint of russetting, it would appear that possibly the 8-nozzle rod should be discontinued after the calyx application, but the difference may be due to natural differences between rows in respect to russetting.

BLUEBERRY DISEASES. Florence L. Markin. Blueberry crop losses from various foliage diseases were comparatively moderate in many localities of Maine during 1933 but heavier than usual in the Frankfort to Waldoboro region. Mildew was the most abundant and destructive of these diseases. Leaf rust was less common than usual. The brown leaf-spot which has caused consid-

erable damage in south central Maine was less severe there than previously observed, and of greater prevalence and severity farther northeast, namely, in Washington County.

Effects of Witches' Broom. Low-bush blueberries (chiefly *Vaccinium pennsylvanicum*) in the North Sedgwick nursery infected with the witches' broom rust produced an average of 33 per cent less yield than plants showing no symptoms of the disease. These plants apparently succumb to this disease more slowly than nearby varieties of *V. corymbosum* from the Whitesbog nurseries.

Fungicidal Treatments to Control Foliage Diseases. Copper-lime dust containing 25 per cent monohydrated copper sulfate to 75 per cent hydrated lime was used in the 1933 experiments unless otherwise stated, because copper-lime dusts have consistently given better results in past experiments than sprays and other dusts. More experiments were conducted on time, number and rates of applications and less on materials than in previous years. All materials have been applied with hand dusters and sprayers.

1. Time of application. Copper-lime dust was applied to one series of plots at weekly intervals beginning May 25 when the blueberry plants were leafing out and coming into blossom, until June 22 about 10 to 12 days after blossom-fall. Each plot received one moderate application, that is, a sufficient amount to give the foliage a thorough but not heavy coverage. Beginning July 12, two days after the blossom-fall application, there were several days of heavy rainfall which may have increased the beneficial effects of that application.

All three early June applications gave good results, but the one at blossom-fall, as in previous years, was most beneficial. The three plots which received these applications showed a good retention of foliage through the season and the berries harvested were large. Adjacent untreated plots had practically no foliage, and produced berries a third smaller and a yield proportionally less at harvest time.

2. Rate of application. The amount of dust needed to give a certain degree of coverage to the foliage varied considerably because of the wind velocity and method of application but, roughly, 18, 36 and 60 pounds of copper-lime dust per application per acre were used to give what were considered to be light, moderate, and heavy applications of dust, respectively. Two applications

were made—on June 2 and June 10. The plots receiving moderate applications gave an increase in yield of 125 per cent, while those with light and heavy applications gave increases of 74 and 86 per cent, respectively.

3. Number of applications. Some plots were dusted on either June 2 or June 10 and others on both dates. The appearance of plants on all three sets of plots was much the same at the end of the season. The comparative yields of the one-application plots were higher. Due to variation in field conditions no conclusions were drawn.

4. Comparison of materials. The yield increases were somewhat greater on plots which had had applications of copper-lime dust containing 20 per cent monohydrated copper sulfate and 80 per cent lime, than on other plots which had received either a 25 per cent copper-lime dust or one containing 38 per cent copper sulfate, 14 per cent calcium arsenate and 48 per cent lime. This is in agreement with most previous results.

5. Year of treatment. Blueberry land is usually burned over one year, produces crops the following two years, and then is burned again. To date, fungicidal treatments applied the year of burning have had little effect on disease prevalence and yield the succeeding year. Treatment the year after burning has often resulted in greater vigor and increased yields the next year provided that there was good disease control and no injury the year of application. Thus, in 1933, on plots burned in 1931 and dusted in 1932, the foliage developed earlier, the leaves were greener and more abundant, and the berries were larger and more numerous than on untreated checks. Dust applied to other plots in this same piece in 1933 only, gave good foliage-disease control but the plants remained less vigorous than those treated in 1932. These facts do not necessarily hold for a field that is in vigorous condition and yields a good second crop. Part of this field was also treated both in 1932 and 1933 with good results.

The percentage increase in yield of plants treated the second year of bearing over untreated checks was much higher than that for dusted plants bearing their first crop, but often, as in the present case, the second crop is so small that the actual increase in yield is negligible.

In conclusion, experiments on control of foliage diseases on vigorous plants in Washington County have shown that one or two applications of certain copper-line dusts applied the year after burning near the time of blossom-fall usually result in sufficient increases in yield to make dusting pay.

The Relationship Between Leaves, Berries, and Fruit Buds. Records have been taken from individual stems from various plots for the purpose of obtaining more reliable information on the effect of disease control on the plants than can be obtained from plot yield records. Leaf counts were taken on the same stems late in July, before defoliation, and again at harvest time the last of August. Analysis of data obtained in 1932 shows the following relationships between plant parts, and gives the following relationships expressed as coefficients of correlation, r :

Number of leaves	early vs. yield,	0.73 ± 0.07 .
" " "	at harvest vs. yield,	0.84 ± 0.05 .
" " "	early vs. number of berries harvested,	0.56 ± 0.11 .
" " "	at harvest vs. number of berries harvested,	0.72 ± 0.08 .
" " "	early vs. size of berries,	0.56 ± 0.16 .
" " "	at harvest vs. size of berries,	0.72 ± 0.08 .
" " "	berries vs. size of berries,	0.49 ± 0.12 .
" " "	" yield,	0.92 ± 0.03 .
Yield vs. size of berries,		0.78 ± 0.06 .
Number of leaves	early vs. number of fruit buds formed,	0.78 ± 0.06 .
" " "	at harvest vs. number of fruit buds,	0.66 ± 0.09 .

Odds were highly significant for all except the third, fifth, and seventh. The following conclusions can be drawn:

1. Number of berries, number of leaves especially at harvest, and size of berries are factors which bear a very definite relationship to yield.

2. The number of leaves retained to harvest was generally somewhat more important than the number of leaves developed early in the season, in affecting yield and number and size of berries harvested.

3. The number of fruit buds formed was naturally more directly related to the number of leaves present at time of bud formation (July) than to the number of leaves at harvest.

A sufficient amount of copper-lime dust to give control of foliage diseases did not upset the relationships of the above factors to one another, and by the prevention of defoliation resulted in increases in yield and to some extent in number of fruit buds formed.

CORN WILT. Florence L. Markin. A very serious disease of sweet corn, bacterial wilt (*Bacterium stevarti*), was found in Maine for the first time in 1933. General and heavy infections occurred in York, Cumberland, and Oxford Counties and a slight amount was observed in Hancock County. Coinciding with a succession of mild winters and above-average temperatures in late spring and early summer, wilt has been increasing and spreading in the United States for several years. The disease is very destructive on early varieties of yellow sweet corn, and to a less extent on flint, dent, and other varieties. The earliest varieties and the earliest plantings are the ones most severely attacked. The only successful means of control seems to lie in the use of resistant varieties. Many resistant varieties developed elsewhere in the United States appear to mature too late for satisfactory plantings under Maine conditions. Should corn wilt persist and increase in the State new varieties of sweet corn resistant but earlier than those now available will need to be developed for our use.

ANNOUNCEMENTS

NEW EQUIPMENT

Early in the spring, the Board of Trustees of the University appropriated funds for the installation of an adequate water system at Highmoor Farm. A shallow well was dug just west of the Golden Delicious orchard and a storage basin ten feet square was constructed below ground level. The storage basin was constructed of matched piling and was covered and banked to protect it from freezing. An automatic pump was installed with a capacity for delivering 30 gallons of water per minute at the buildings. The pressure is maintained automatically between 50 and 80 pounds. For use in case of fire, special devices have been installed whereby a pressure of 150 pounds may be obtained.

A special fire line the full length of the buildings was installed with fire hose so that with the water supply available the buildings are reasonably well protected from fire.

The flow of water into the well was checked and found to be about 50 gallons per minute at the bottom of the well. The storage basin contains, at normal, about 12,000 gallons. It may be assumed from the foregoing that the water supply at Highmoor is sufficient for all purposes, including reasonably adequate fire protection. This is the first year that it has been unnecessary to haul water at Highmoor Farm for use in spraying the orchards and in watering the livestock.

Acknowledgment is given to Paul L. Bean of the Union Water Power Company, Lewiston, for his valuable advice and guidance in locating the supply of water and in the selection of the proper equipment.

COUNCIL AND STAFF CHANGES

The following change was made in the Station Council: Mr. Ross Elliott succeeded Mr. John W. Leland as representative of the State Dairymen's Association.

In the death of Dean Leon S. Merrill on September 3, 1933, agriculture suffered a loss of one of its most staunch supporters.

The changes in the Station Staff are as follows: Miss Lolie Smith, Associate Home Economist, resigned to be effective July 1, 1933. Miss Merna Monroe was appointed Assistant Home Economist.

Doctor Clarence R. Phipps died on June 21, 1933 and thus was removed from the Station Staff one of its most valuable research workers.

PROJECTS FOR 1933-1934

AGRICULTURAL ECONOMICS

An economic study of the dairy industry in Maine.

An economic study of the potato industry in Maine.

Local market conditions and requirements of agricultural products in Maine (except Aroostook County).

BIOLOGY

- The relation between shape and yield of apple trees.
- Breeding new varieties of apples.
- Nursery stock investigations in relation to bud selection in the apple.
- Causes of cross and self sterility in certain plants, particularly the apple, through a cytologic and genetic study.
- A study of the fertilizer requirements of the native Maine blueberry.
- Breeding investigations with the blueberry.
- Blueberry field management.
- Fruitfulness in the blueberry.
- Weed control in blueberry fields.
- The mode of inheritance of milk production and associated characters in cattle.
- Breeding investigations with garden crops.
- Fertilizer experiments with potatoes in rotation with grain and clover.
- A study of clover failures in a potato rotation.
- A study of various green manuring crops as a means of increasing and maintaining the organic matter content of potato soils in two-, three-, and four-year rotations.
- A study of the physiology of reproduction in poultry.
- Influence of anti-rachitic substances on growth in poultry.
- Fertilizer experiments with sweet corn and beans in a four-year rotation—oats, clover, sweet corn, and beans and with sweet corn in a two-year rotation—sweet corn and an annual green manuring crop (mixture of oats and peas).
- Inheritance of certain characters in relation to yield and quality in sweet corn and beans.
- Cytological studies in species crosses.
- Small grain variety test including oats, barley, and wheat.
- Breeding investigation with small fruits, particularly raspberries and strawberries.

CHEMISTRY

INSPECTION

- Inspection of feeding stuffs.
- Inspection of fertilizers.
- Inspection of foods and drugs.
- Inspection of fungicides and insecticides.
- Inspection of seeds.
- Inspection of gasolines and oils.
- Calibration of creamery glassware.
- Inspection of milk and cream.
- Miscellaneous analyses.

INVESTIGATION

Chemical composition of cows' milk in parents and hybrid offspring.

(In cooperation with the Biology Department).

Chemical analyses in connection with the problem of nutrition and growth of poultry and dairy cattle. (In cooperation with the Biology Department.)

Soil acidity investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm. (In cooperation with the Biology Department.)

A comparison of copper fungicides as to the adherence of the copper contents to potato foliage in spraying and dusting. (In cooperation with the Plant Pathology Department.)

Miscellaneous analyses.

ENTOMOLOGY

Aphid investigations with special reference to the different food plants of migratory species.

A study of apple maggot problems including dispersal.

Insects affecting the blueberry.

Control of the cabbage maggot.

Experiments with sodium and calcium fluosilicates in the control of the cucumber beetle and other insects.

Cutworms affecting field and garden crops.

Insects in relation to the transmission of virus diseases of potatoes.

Garden slug control.

Wireworms affecting field and garden crops.

A study of the life history and control of the Mexican bean beetle in Maine.

HOME ECONOMICS

The economic utilization of electricity in food preparation in Maine rural homes.

The factors affecting the cooking quality of potatoes.

A study of the financing by Maine families of the higher education of their children in Maine institutions.

PLANT PATHOLOGY

Apple scab control.

Blueberry diseases.

Cucurbit disease control.

Differentiation and dissemination of potato virus diseases.

Dusting and spraying potatoes.

Economic effects and control of potato virus diseases.

Histology and ecology of potato tuber rots.

Identification and dissemination of causes of potato rots.

Seed disinfection of potatoes.

Stem-end browning of potato tubers.

Plant disease survey and miscellaneous diseases. Annual recording, through correspondence and observations, of the prevalence and severity of plant diseases, and preliminary experiments on miscellaneous diseases that develop importance.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and are bound with the annual report as an appendix thereto. Miscellaneous publications consisting of newspaper notices of bulletins, newspaper bulletins and circulars which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

BULLETINS ISSUED IN 1933

- No. 364. Prices of Farm Products in Maine. 179 pages.
- No. 365. The Effect of Handling Methods on Quality of Maine Potatoes. 42 pages.
- No. 366. Farm-Property Taxation in Maine. 64 pages.
- No. 367. An Economic Study of the Production and Utilization of Milk in Maine. 131 pages.
- No. 368. Apple Spraying and Dusting Experiments 1928 to 1932 in Relation to Scab, Yield, and Tree Growth. 86 pages.
- No. 369. Summary Report of Progress 1933. 94 pages.

OFFICIAL INSPECTIONS ISSUED IN 1933

- No. 147. Foods and Drugs. 20 pages.
- No. 148. Commercial Feeding Stuffs, 1932-33. 48 pages.
- No. 149. Commercial Fertilizers, 1933. 28 pages.
- No. 150. Commercial Agricultural Seeds, 1933. Fungicides and Insecticides, 1933. 28 pages.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1933
BUT NOT INCLUDED IN THE BULLETINS

A complete list of all the Bulletins issued by and from the Station in 1933 is given on page 585 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

ON THE GENETIC CONSTITUTION OF JERSEY CATTLE AS INFLUENCED
BY INHERITANCE AND ENVIRONMENT*

This paper presents a summary of the body constitution of Jersey cattle as it is found after centuries of evolution under domestication and after separation from other cattle for a period of nearly 200 years. The cattle utilized were pure-bred Jerseys owned within 15 states of the United States. Nearly 6,000 relatively high-grade Jerseys form the basis for this study.

Data are presented to show the amount of residual inheritance for body constitution which remains within the breed as a whole and on the individual farms where the breeding is carried on. The parent and offspring and sibship correlations are presented. These correlations show that inheritance accounts for most of the variation in the size of these cattle, such environmental differences as do exist playing but little part in the ultimate constitution of these animals. The data show high coefficients of assortive mating. These are particularly noticeable for the hip width, body length, and rump length. These coefficients are sufficiently large to indicate the separation of the Jersey cattle into non-interbreeding groups, each of these groups being characterized by a definite type. Study of the residual variation, subject to the control of the inheritance, which is left within the groups, shows that it has been much reduced in the cattle of any one herd. The individual owners have consequently utilized to nearly its full measure the inheritance which was present initially within the breed. Further selection within the herds consequently must be devoted to the more refined points, or if extensive changes in type are desired resort must be had to crosses between families of the desired types.

* This is a summary of a paper by John W. Gowen, having the same title and published in *Genetics* 18: 415-440. 1933.

THE PHYSICO-CHEMICAL CHANGES PRODUCED BY COOKING
POTATOES*

A review of literature is supplemented by conclusions from work in the Maine Agricultural Experiment Station. It is shown that the cooking of potatoes does not cause the bursting of cell walls but permits ready mechanical disintegration of the tuber tissue by separation of cells. The process is characterized by such physico-chemical changes as partial gelatinization of the starch, the solution of some of the pectic substances, the increased digestibility of the cellulose, the coagulation of most of the protein, and more or less caramelization of the sugar. Probably constituents present in smaller proportions are also important in their effects on culinary quality.

EFFECT OF SCAB-PREVENTIVE TREATMENTS ON APPLE-TREE GROWTH
AND YIELD*

In a young McIntosh apple orchard in Maine, 350 trees were studied for five years in 45 replicated plots. Four series, respectively, received sulphur dry mix, sulphur dust, lead arsenate, and dry lime sulphur during this period and produced average stem diameters of 41, 40, 39, and 38 mm. A fifth series, receiving flotation sulphur three years and nothing two years, grew to 38 mm. The diameter differences here were not significant statistically and were much less than the generally significant stem-diameter differences found with several natural modifications of the soil, a sandy loam. In an adjacent older McIntosh orchard in 28 comparisons, each involving a series of trees treated with unmodified dry lime sulphur, this material generally tended to increase rather than decrease fruit yield and had no effect on rate of girth increase. Here, in 20 comparisons, using individual-tree data, there generally was no significant correlation between leaf scab, leaf-spray injury, yield, and growth within the same season, while further correlations showed an interdependence of fast growth, earliness of first yield, and the yield rate for a period of recent years.

* This is an abstract of a paper by Marion Deyoe Sweetman having the same title and published in the *Amer. Potato Jour.* 10: 169-173. 1933.

* This is an abstract of a paper by Donald Folsom, having the same title and published in *Phytopathology* 23: 11. 1933.

POTATO VIRUS DISEASES IN 1932*

The spinach aphid is the chief agent of spread of leafroll (Indiana, Holland, New Zealand) though potato aphids and leafhoppers also can transmit (Indiana), while potato aphids, flea beetles, and thrips sometimes do not transmit (Indiana, New Zealand). Mosaic spread to healthy stocks before July 5, reaching 26 per cent of the tubers by July 26 (Holland). Leafroll was transmitted 750 feet in one place and over a mile in another (England). Disease increased less in fields nearer a northern seacoast in accordance with less abundance of aphids (Wales, Holland). The well-known virus diseases are not correlated with tuber size (Belgium) or stem-end browning (Canada) and attempts to develop a practical way to ascertain them in the individual tuber have failed in various places. Soil type is not a determining factor (Holland). In Oregon, control is most practical by means of roguing tuber-unit seed plots except that Irish Cobblers are immune to mild mosaic. In Washington, the "latent virus" of apparently healthy plants was absent from only one of 655 tested tubers from six commercial varieties. In England, virus-free stocks of eight or more varieties have been isolated and multiplied and found to be superior in vigor and production. In Indiana, where leafroll spreads variably but generally rapidly, spraying with a combination of Bordeaux mixture, lead arsenate, and nicotine sulphate reduced leafhopper infestation and the spread of leafroll.

BOTRYTIS CINEREA AS A CAUSE OF POTATO TUBER ROT*

Botrytis cinerea was readily isolated in different seasons from a rot of potato tubers stored in Maine. In this type of rot the skin becomes wrinkled, while the flesh easily loses water under pressure. Where advancing rapidly, the rot causes a temporary dark-

*This is an abstract of a literature review by Donald Folsom, having the same title and published in the Amer. Potato Journal 10: 224-233. 1933. Only the reliable and new data of most interest to Maine potato growers are given here, with the regions from which the data came.

*This is an abstract of a paper by Donald Folsom having the same title and published in Phytopathology 23: 993-999. 1933. A preliminary abstract of this paper with a different title was published in Phytopathology 23: 11. 1933.

ening of the flesh. Different cultures of the fungus, including some isolated from potato foliage and stems during an epidemic of *Botrytis* blight in the field, have, under certain conditions, caused the same kind of rot as that found in storage. A different form of rot also has been obtained under certain other conditions, where all inoculations have been successful but where the lesion did not penetrate more than one or two centimeters deep. The fungus has been reisolated, reinoculated, and again reisolated, without particular difficulty except where conditions were very favorable for wound repair.

AVAILABLE REPRINTS OR SEPARATES

Following is a list of reprints of articles published in various periodicals. These will be of interest chiefly to research workers and teachers but will be mailed free to anyone upon request so long as the supply lasts.

AGRICULTURAL ECONOMICS

1929. Electricity on Maine farms. Prepared by Charles H. Merchant.

BIOLOGY

1909. Miscellanea. I. Fecundity of swine. By Frank M. Surface.
1911. Inheritance in blood lines in breeding animals for performance with special reference to the 200-egg hen. By Raymond Pearl.
1911. Shorter articles and discussion, biometric arguments regarding the genotype concept. By Raymond Pearl.
1914. A biometrical study of egg production in the domestic fowl. III. Variation and correlation in the physical characters of the egg. By Raymond Pearl and Frank M. Surface.
1914. The relative time of fertilization of the ovum and the sex ratio amongst Jews. By Raymond Pearl and Redcliffe N. Salaman.
1914. Some physiological observations regarding plumage patterns. By Raymond Pearl and Alice M. Boring.
1914. Studies on the physiology of reproduction in the domestic fowl. VII. Data regarding the brooding instinct in its relation to egg production. By Raymond Pearl.
1914. Studies on inbreeding—IV. On a general formula for the constitution of the n th generation of a Mendelian population in which all matings are of brother \times sister. By Raymond Pearl.
1914. Studies on inbreeding—V. Inbreeding and relationship coefficients. By Raymond Pearl.

1914. Studies on the physiology of reproduction in the domestic fowl. IX. On the effect of Corpus luteum substance upon ovulation in the fowl. By Raymond Pearl and Frank M. Surface.
1914. On the refractive index of the serum in a guinea-chicken hybrid. By Raymond Pearl and John W. Gowen.
1915. Relation of simultaneous ovulation to the production of double-yolked eggs. By Maynie R. Curtis.
1915. Studies on the physiology of reproduction in the domestic fowl. XII. On an abnormality of the oviduct and its effect upon reproduction. By Maynie R. Curtis.
1915. Fitting Logarithmic curves by the method of moments. By John Rice Miner.
1915. Interpolation as a means of approximation to the gamma function for high values of n . By Raymond Pearl.
1915. Mendelian inheritance of fecundity in the domestic fowl, and average flock production. By Raymond Pearl.
1915. Studies on inbreeding—VI. Some further considerations regarding cousin and related kinds of mating. By Raymond Pearl.
1915. Frequency of occurrence of tumors in the domestic fowl. By Maynie R. Curtis.
1915. Seventeen years selection of a character showing sex-linked Mendelian inheritance. By Raymond Pearl.
1915. Measurement of the winter cycle in the egg production of domestic fowl. By Raymond Pearl.
1915. On the degree of exactness of the gamma function necessary in curve fitting. By Raymond Pearl.
1916. A method of correcting for soil heterogeneity in variety tests. By Frank M. Surface and Raymond Pearl.
1916. Fecundity in the domestic fowl and the selection problem. By Raymond Pearl.
1916. On the inheritance of certain glume characters in the cross *Avena fatua* x *A. sativa* var. Kherson. By Frank M. Surface.
1916. Studies on the physiology of reproduction in the domestic fowl. XV. Dwarf eggs. By Raymond Pearl and Maynie R. Curtis.
1916. A note on the inheritance of eye pattern in beans and its relation of type of vine. By Frank M. Surface.
1916. On the effect of continued administration of certain poisons to the domestic fowl, with special reference to the progeny. By Raymond Pearl.
1916. On the differential effect of certain calcium salts upon the rate of growth of the two sexes of the domestic fowl. By Raymond Pearl.
1916. Some effects of the continued administration of alcohol to the domestic fowl, with special reference to the progeny. By Raymond Pearl.
1917. The experimental modification of germ cells. III. The effect of parental alcoholism, and certain other drug intoxications, upon the progeny. By Raymond Pearl.
1917. The probable error of a difference and the selection problem. By Raymond Pearl.

1917. A note on the fitting of parabolas. By John Rice Miner.
1917. The probable error of a Mendelian class frequency. By Raymond Pearl.
1917. The selection problem. By Raymond Pearl.
1917. Studies on the physiology of reproduction in the domestic fowl. XVII. The influence of age upon reproductive ability, with a description of a new reproductive index. By Raymond Pearl.
1917. Studies on oat breeding—V: The F_1 and F_2 generations of a cross between a naked and a hulled oat. By Jacob Zinn and Frank M. Surface.
1917. Sex studies. By Alice M. Boring and Raymond Pearl.
1917. Studies on inbreeding—VIII. A single numerical measure of the total amount of inbreeding. By Raymond Pearl.
1919. Variation of Ayrshire cows in the quantity and fat content of their milk. By Raymond Pearl and John Rice Miner.
1919. On variation in Tartary buckwheat, *Fagopyrum tataricum* (L.) Gaertn. By Jacob Zinn.
1921. Productive and unproductive types of apple trees. Studies in orchard management. IV. By Karl Sax and John W. Gowen.
1921. Chromosome relationships in wheat. By Karl Sax.
1921. Simple device for weighing seeds. By Karl Sax.
1922. Identical twins in cattle. By John W. Gowen.
1922. Sterility in wheat hybrids. II. Chromosome behavior in partially sterile hybrids. By Karl Sax.
1922. Sterility in wheat hybrids. III. Endosperm development and F_2 sterility. By Karl Sax.
1923. Correlations between various characters of wheat and flour as determined from published data from chemical milling, and baking tests of a number of American wheats. By Jacob Zinn.
1923. The relation between chromosome number, morphological characters and rust resistance in segregates of partially sterile wheat hybrids. By Karl Sax.
1923. Bud and root selection in the propagation of the apple. By Karl Sax.
1924. Chromosome behavior in a genus cross. By Karl Sax and Hally Jolivet Sax.
1924. The "probable error" in horticultural experiments. By Karl Sax.
1924. The nature of size inheritance. By Karl Sax.
1924. A genetic and cytological study of certain hybrids of wheat species. By Karl Sax and E. F. Gaines.
1924. The inheritance of milk production and butterfat percentage. By John W. Gowen.
1924. Inheritance of milk production. By John W. Gowen.
1924. Nursery stock investigations. By Karl Sax.
1924. Genetic and physiological analysis of cattle problems. By John W. Gowen.
1926. A genetical interpretation of ecological adaptation. By Karl Sax.
1926. Cystic testes, a cause of male sterility in the domestic fowl. By John W. Gowen.

1926. Quantitative inheritance in phaseolus. By Karl Sax.
1926. Rickets, ultra-violet light and milk. By John W. Gowen, J. M. Murray, M. E. Gooch, and Forrest B. Ames.
1926. Judging of dairy cattle and some of its problems. By John W. Gowen.
1927. A résumé of cattle inheritance. By John W. Gowen.
1928. Calculating linkage intensities by product moment correlation. By F. V. Owen.
1928. Sex sterility and the diminutive copulatory organ in the domestic fowl. By W. Franklin Dove.
1928. The influence of environmental factors on pigment patterns in varieties of common beans. By F. V. Owen, Iva M. Burgess, and C. R. Burnham.

ENTOMOLOGY

1909. Downy Psyllid of alder, *Psylla floccosa*, new species. By Edith M. Patch.
1912. Notes on Psyllidae: *Livia*. By Edith M. Patch.
1913. The immature stages of the Tenthredinoidea. By Alex. D. MacGillivray.
1913. A note on two elm leaf aphides. By Edith M. Patch.
1914. List of the Hemiptera-Heteroptera of Maine. By H. M. Parshley.
1914. A note on Rhagoletis pomonella in blueberries. By William C. Woods.
1915. The pond-lily aphid as a plum pest. By Edith M. Patch.
1916. Concerning problems in aphid ecology. By Edith M. Patch.
1917. Eastern aphids, new or little known. Part I. By Edith M. Patch.
1920. The life cycle of aphids and coccids. By Edith M. Patch.
1922. Aroostook potato insects. By Edith M. Patch.
1923. Homoptera of the Pribilof Islands, Alaska. By Edith M. Patch.
1924. Aphids with branched cornicles (Homop.) By Edith M. Patch.
1925. The primary foodplant of the melon aphid. By Edith M. Patch.
1926. *Xanthonia Decem-notata* Say, an apple pest in Maine (Coleoptera, Chrysomelidae). By C. R. Phipps.
1929. The apple aphid and the citrus aphid: *Aphis Pomi* Degeer and *A. spiraeicola* Patch. By Edith M. Patch.
1929. *Syneda allenii* Grt., a cutworm destructive to blueberry in Maine. By C. R. Phipps.
1930. Wireworm control in Maine. By J. H. Hawkins.
1930. Tarsal claws of noctuid larvae. By J. H. Hawkins.
1932. Dispersal of the apple maggot. By C. R. Phipps and C. O. Dirks.
1933. Dispersal of the apple maggot—1932 studies. By C. R. Phipps and C. O. Dirks.

PLANT PATHOLOGY

1912. Does the potato scab organism survive passage through the digestive tract of domestic animals? By W. J. Morse.
1913. Powdery scab of potatoes in the United States. By W. J. Morse.

1913. Is apple scab on young shoots a source of spring infection? By W. J. Morse and W. H. Darrow.
1915. Effect of temperature on germination and growth of the common potato-scab organism. By Michael Shapovalov.
1917. Studies upon the blackleg disease of the potato, with special reference to the relationship of the causal organisms. By W. J. Morse.
1917. A form of potato disease produced by *Rhizoctonia*. By Glen B. Ramsey.
1918. Influence of moisture and temperature upon infection by *Spongospora subterranea*. By Glen B. Ramsey.
1919. Studies on the viability of the potato blackleg organism. By Glen B. Ramsey.
1921. The transference of potato late blight by insects. By W. J. Morse.
1930. Effect of seed-potato treatment on yield and *Rhizoctonia* in northeastern Maine from 1925 to 1928. By E. S. Schultz, L. O. Gratz, and Reiner Bonde. /

METEOROLOGICAL OBSERVATIONS

For many years the meteorological records were made at the Experiment Station by members of the Station staff. This work was transferred to the Department of Physics of the University of Maine on June 1, 1911. The Station is indebted to the Department of Physics for the meteorological summary for 1933 which appears on the following page.

The instruments used are located on the University campus at Lat. $44^{\circ} 54' 2''$ N., Long. $64^{\circ} 40' 5''$ W. Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain gauge, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of sixty-five years.

REPORT OF THE TREASURER

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, and Purnell Fund accounts are also audited by the Office of Experiment Stations acting for the United States Secretary of Agriculture in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1933, was:

U. S. Government, Hatch Fund.....	\$15,000.00
U. S. Government, Adams Fund.....	15,000.00
U. S. Government, Purnell Fund.....	60,000.00
State of Maine, Mill Tax, Other Income, Sales, etc....	54,900.68
State Department of Agriculture	13,710.49
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Total Income.....	\$158,611.17

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations. The cost of printing Station bulletins is paid for by the University in addition to the funds mentioned above.

At Aroostook Farm there are in connection with the cooperative work with the Federal Department of Agriculture certain expenditures for the Department made from sales of crops from Department investigations that do not appear in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1933
DISBURSEMENTS

	Federal Funds			State Funds		
	Hatch	Adams	Purnell	Mill Tax, Other Income, Sales, etc.	Inspections	Total
Salaries -----	\$ 8,945.50	\$15,000.00	\$43,030.85	\$11,670.77	\$10,712.00	\$ 89,849.12
Labor -----	2,544.39	-----	4,114.27	13,588.57	1,569.64	21,816.87
Stationery and Office Supplies -----	168.88	-----	231.91	293.28	43.27	738.84
Scientific Supplies -----	92.14	-----	321.13	214.65	284.81	842.73
Seeding Stuffs -----	124.28	-----	1,650.09	1,091.48	-----	2,865.85
Sundry Supplies -----	182.25	-----	1,037.26	2,500.44	-----	3,765.23
Fertilizers -----	-----	-----	66.75	1,478.23	65.28	1,544.98
Communication Service -----	181.34	-----	36.00	399.67	43.12	660.13
Travel Expenses -----	788.40	-----	4,186.19	1,716.32	31.14	6,722.05
Transportation of Things -----	24.98	-----	140.85	1,907.56	121.87	2,195.26
Publications -----	9.00	-----	9.00	70.32	-----	88.32
Heat, Light, Water, and Power -----	1,179.54	-----	879.24	2,397.91	479.98	4,936.67
Furniture, Furnishings, and Fixtures -----	14.88	-----	554.86	822.52	144.20	1,536.46
Library -----	571.46	-----	46.12	652.53	8.00	1,278.11
Scientific Equipment -----	87.23	-----	872.16	546.94	140.96	1,647.29
Live Stock -----	-----	-----	157.95	4.00	-----	161.95
Tools, Machinery, and Appliances -----	111.47	-----	1,636.68	2,062.92	55.45	3,866.52
Buildings and Land -----	33.43	-----	299.79	13,746.44	3.77	13,083.43
Contingent -----	11.33	-----	738.90	714.32	5.00	1,469.55
Total -----	\$15,000.00	\$15,000.00	\$60,000.00	\$54,878.87	\$13,710.49	\$158,589.36

